Appendix A – Maps of Watershed Units

The following maps show *Arundo* populations within Central Valley watershed units. Maps are ordered from north to south as listed below. The full dataset of *Arundo* populations can be found online on the California Dept. of Fish and Wildlife's BIOS viewer and Cal-IPC's website (references in Chapter 3).

Map 1 - Sac River Headwaters: Castle-Stillwater Creeks Watershed Unit

Map 2 - Cottonwood Creek Watershed Unit

Map 3 - Elder Creek Watershed Unit

Map 4 - Sac River Upper: Cottonwood to Thomes Creeks Sacramento Main Stem Reach

Map 5 - Antelope-Mill Creek Watershed Unit

Map 6 - Thomes Creek Watershed Unit

Map 7 - Stony Creek Watershed Unit

Map 8 - Feather River-Chico-Butte Creeks Watershed Unit

Map 9 - Sac River Middle: Stony to Cache Creeks Sacramento Main Stem Reach

Map 10 - Colusa Trough-Stone Corral-Freshwater Creeks Watershed Unit

Map 11 - Bear-Yuba River Watershed Unit

Map 12 - Cache-Putah Creeks Watershed Unit

Map 13 - Sac River Lower: Cache to Putah Creeks Sacramento Main Stem Reach

Map 14 - American-Mokelumne Rivers-Deer Creek Watershed Unit

Map 15 - Ulatis Creek Watershed Unit

Map 16 - Los Banos-Panoche-Salado Creeks-San Joaquin River Watershed Unit

Map 17- Calaveras River Watershed Unit

Map 18 - Stanislaus-Tuolumne Rivers Watershed Unit

Map 19 - Bear Creek-Merced River Watershed Unit

Map 20 - Chowchilla-Fresno Rivers Watershed Unit

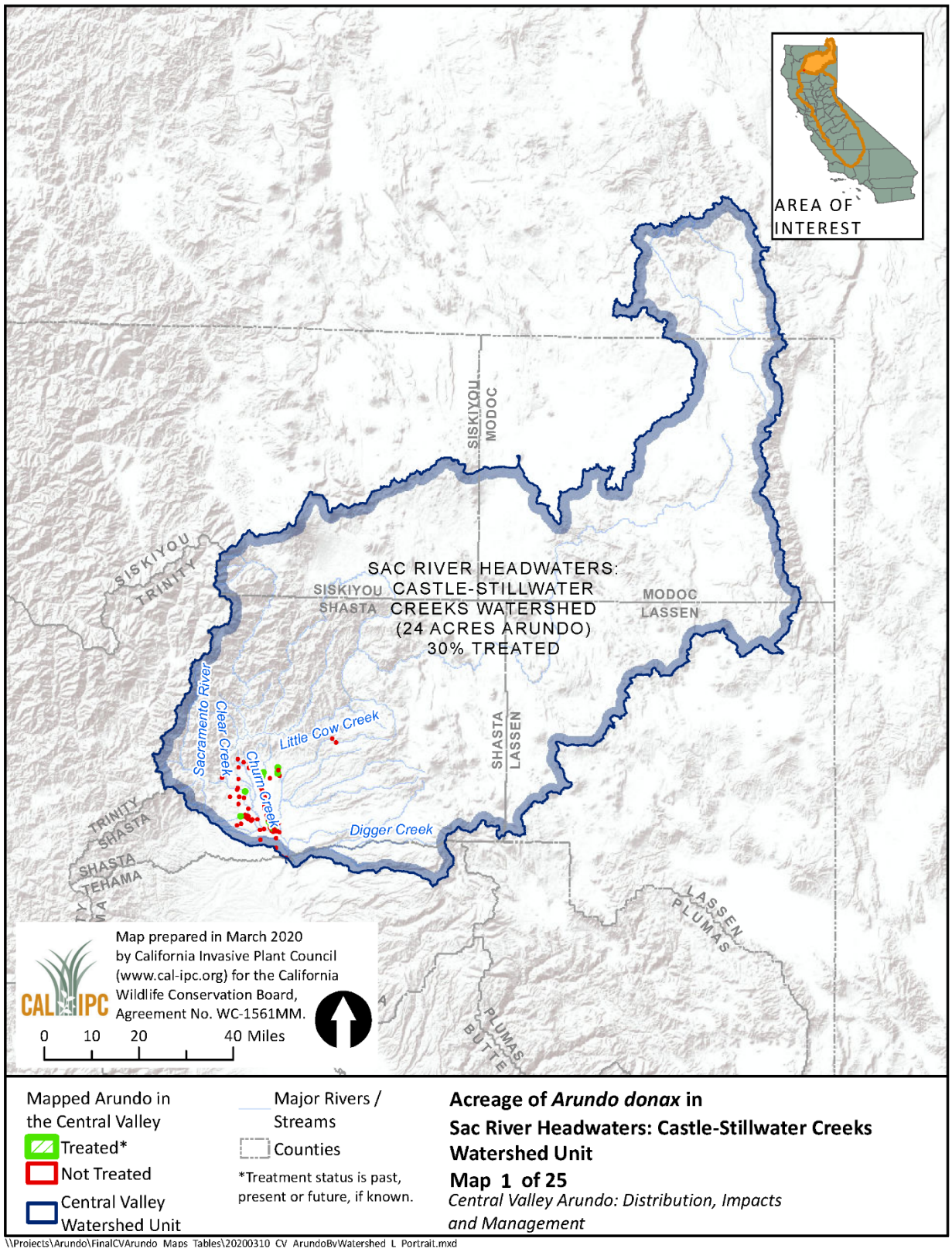
Map 21 - San Joaquin River Watershed Unit

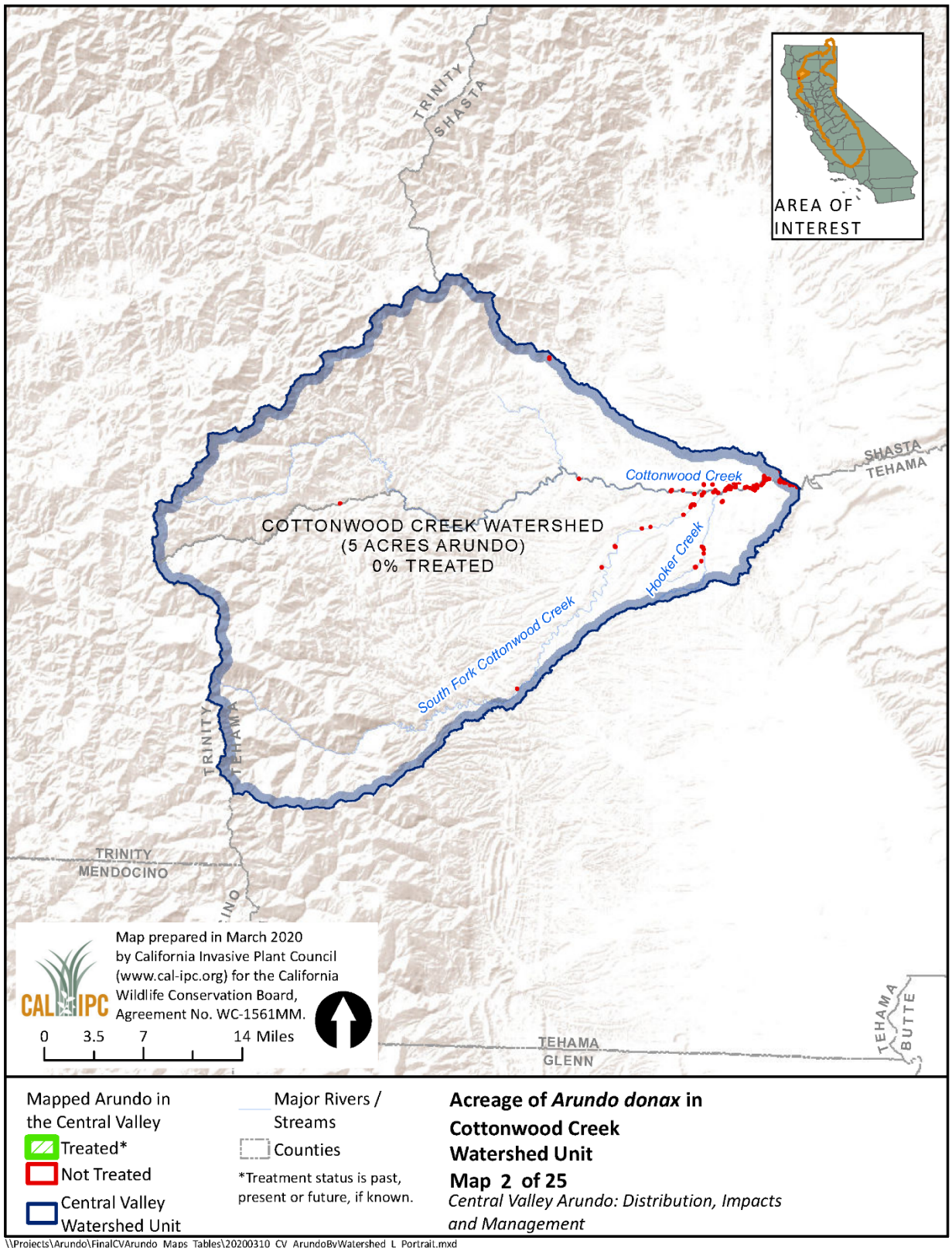
Map 22 - Tulare Lake-Los Gatos Creek Watershed Unit

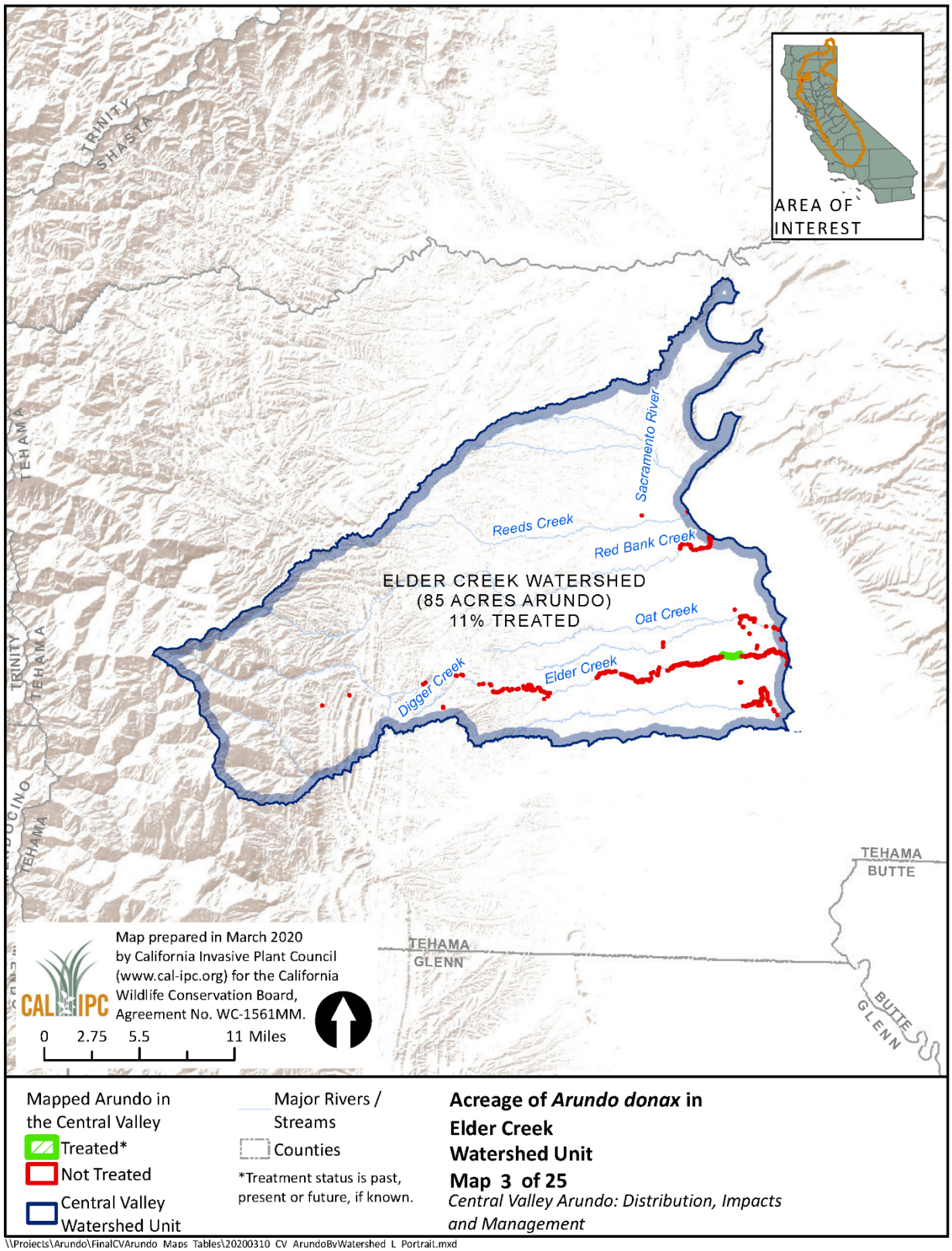
Map 23 - Kings River Watershed Unit

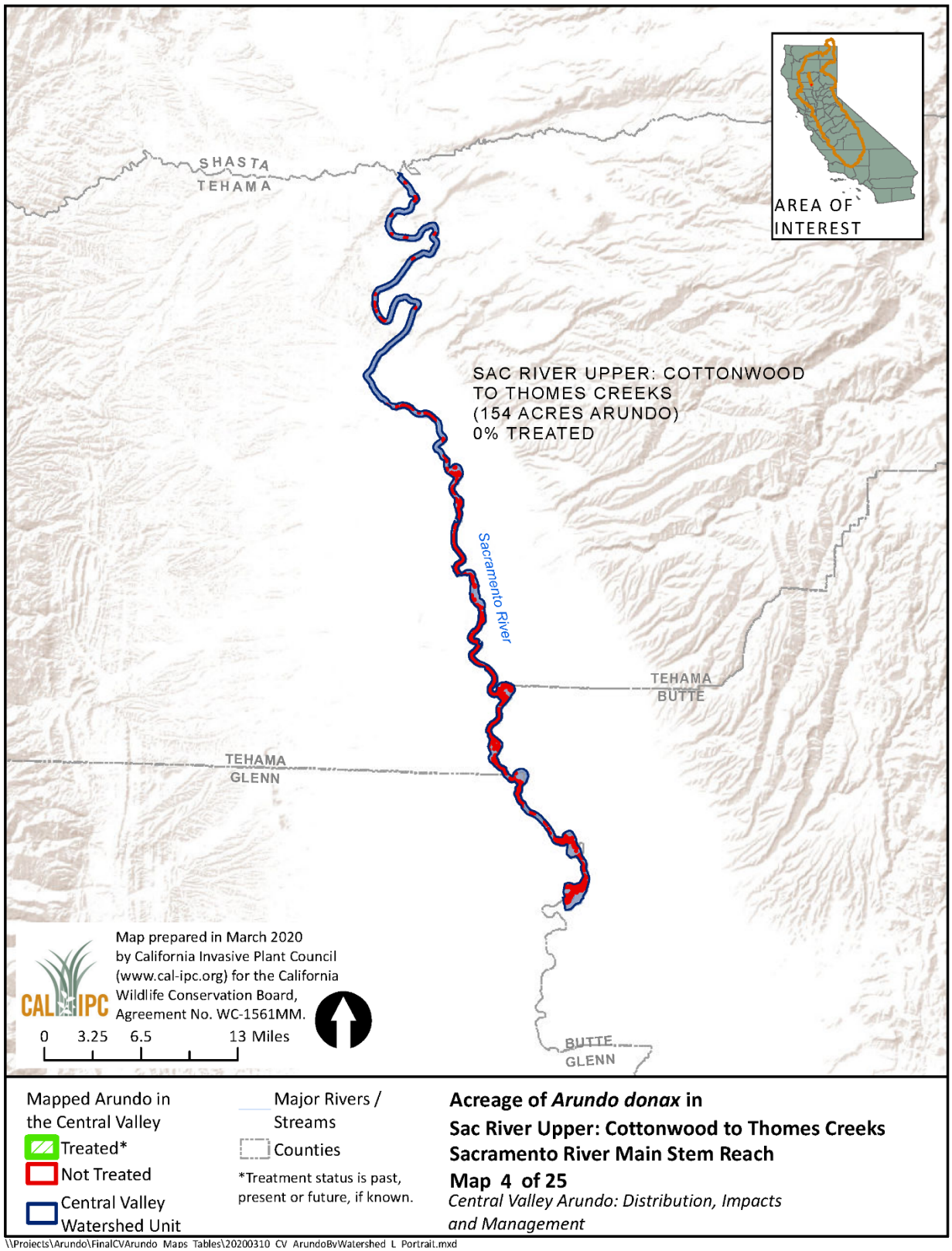
Map 24 - Kaweah-Tule River Watershed Unit

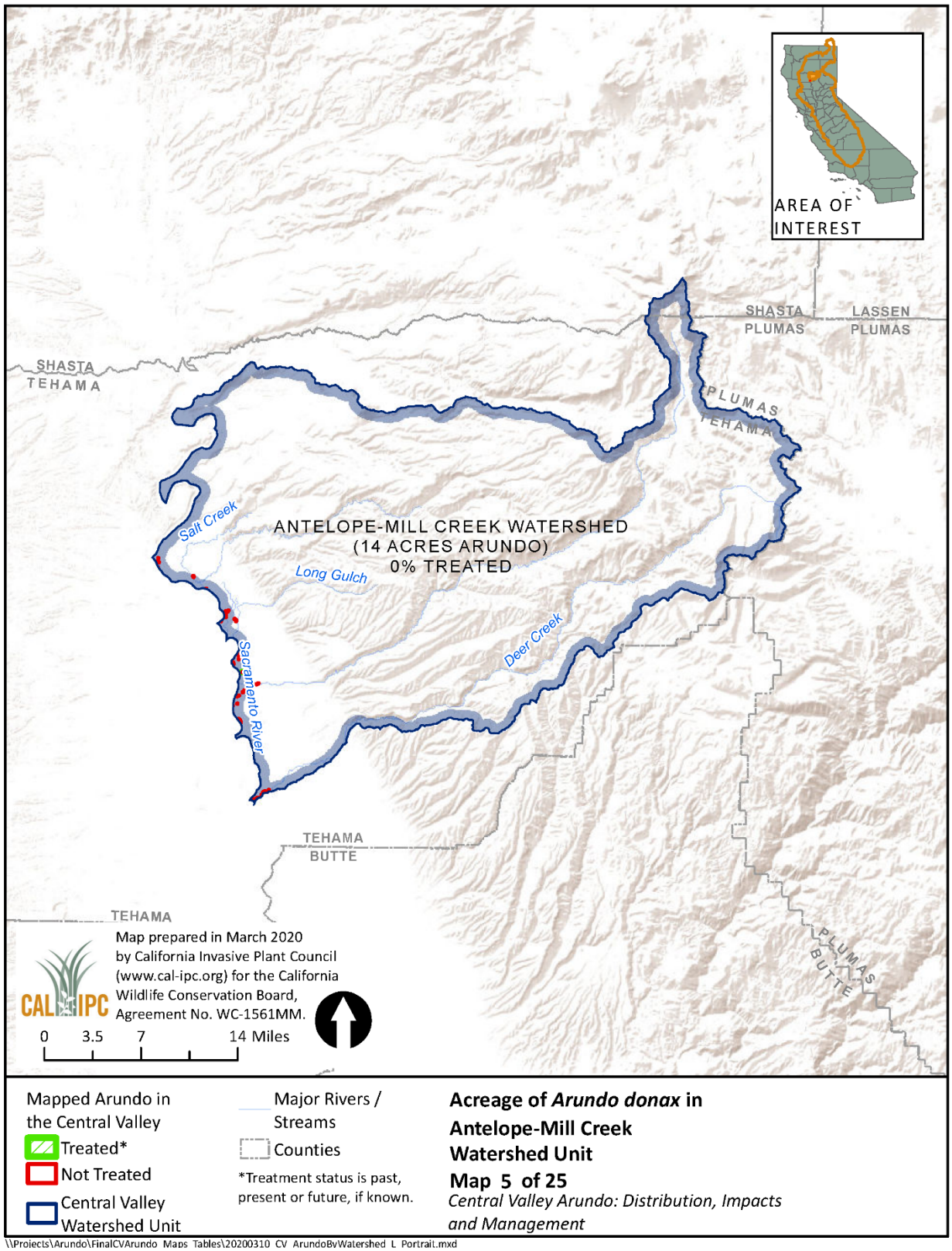
Map 25 - Kern River Watershed Unit

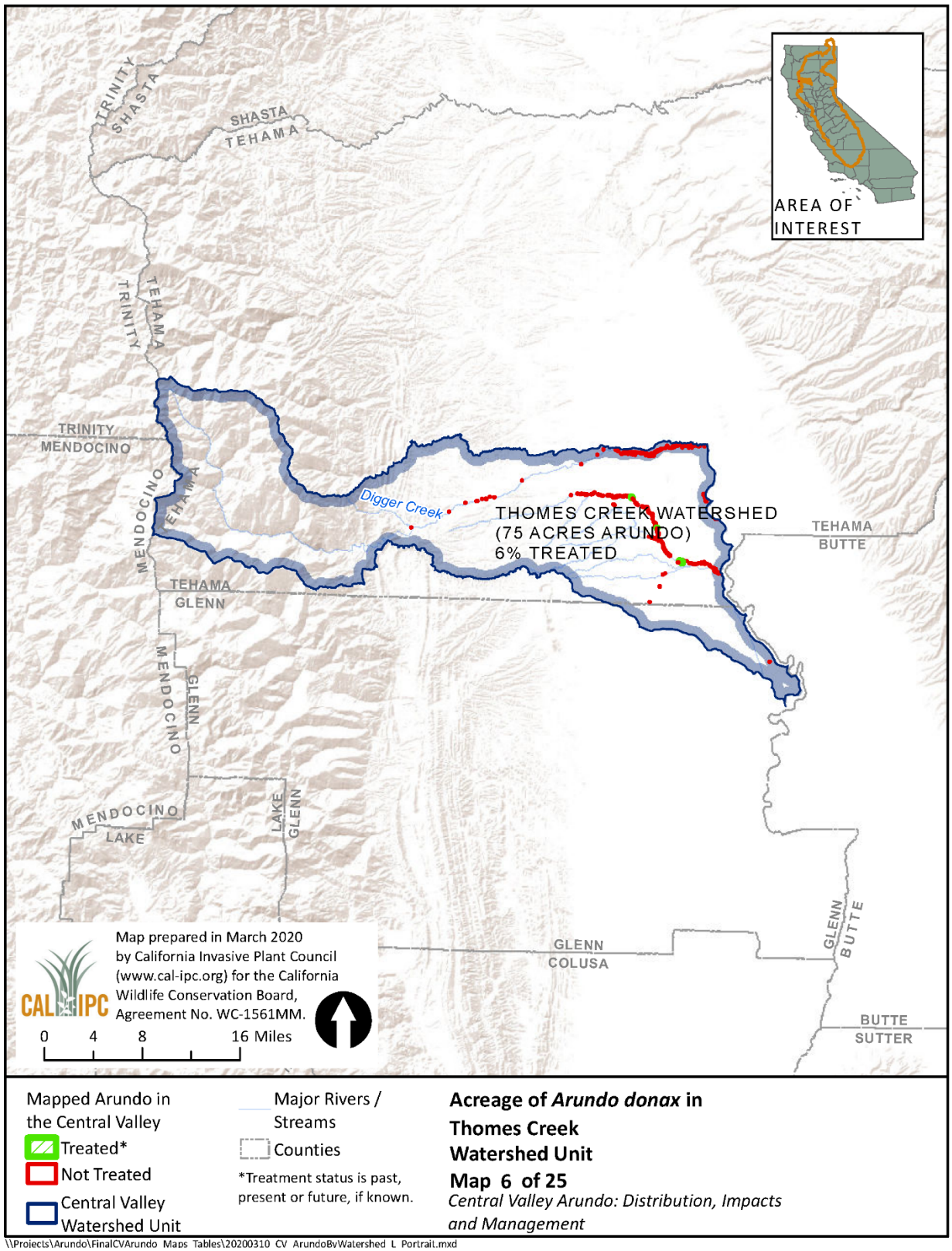

AREA OF INTEREST
SAC RIVER HEADWATERS:
CASTLE-STILLWATER
CREEKS WATERSHED
(24 ACRES ARUNDO)
30% TREATED
SISKIYOU
MODOC
SISKIYOU
TRINITY
SISKIYOU
SHASTA
MODOC
LASSEN
SHASTA
LASSEN
Sacramento River
Clear Creek
Little Cow Creek
Churn Creek
Digger Creek
TRINITY
SHASTA
SHASTA
TEHAMA
LASSEN
PLUMAS
PLUMAS
BUTTE
Map prepared in March 2020
by California Invasive Plant Council
(www.cal-ipc.org) for the California
Wildlife Conservation Board,
Agreement No. WC-1561MM.
0 10 20 40 Miles
Mapped Arundo in the Central Valley
Treated*
Not Treated
Central Valley Watershed Unit
Major Rivers / Streams
Counties
*Treatment status is past, present or future, if known.
Acreage of *Arundo donax* in
Sac River Headwaters: Castle-Stillwater Creeks Watershed Unit
Map 1 of 25
Central Valley Arundo: Distribution, Impacts and Management
\\Projects\Arundo\FinalCVArundo Maps Tables\20200310 CV ArundoByWatershed L Portrait.mxd

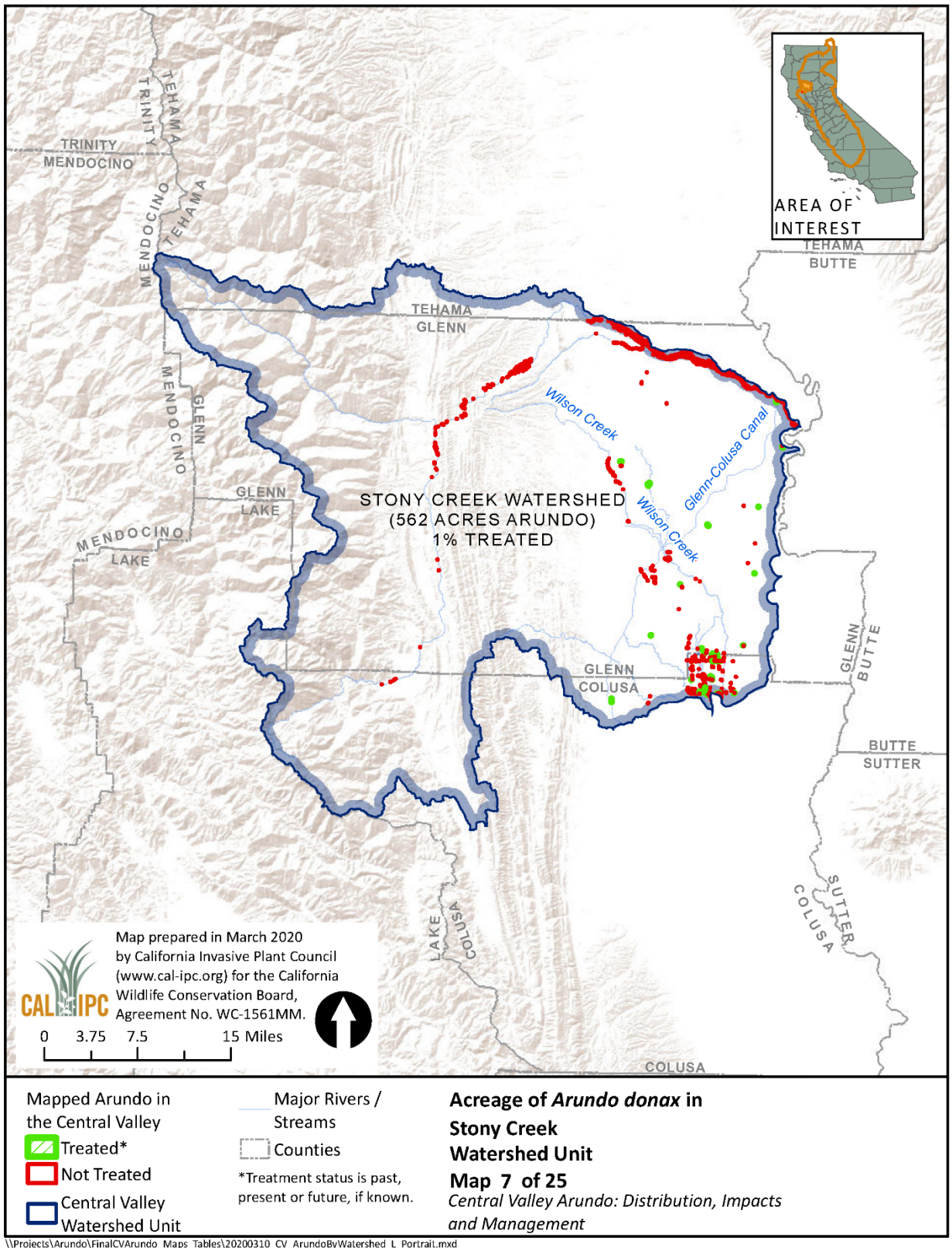

TRINITY
SHASTA
AREA OF INTEREST
Cottonwood Creek
SHASTA
TEHAMA
COTTONWOOD CREEK WATERSHED
(5 ACRES ARUNDO)
0% TREATED
Hooker Creek
South Fork Cottonwood Creek
TRINITY
TEHAMA
TRINITY
MENDOCINO
TEHAMA
GLENN
TEHAMA
BUTTE
Map prepared in March 2020
by California Invasive Plant Council
(www.cal-ipc.org) for the California
Wildlife Conservation Board,
Agreement No. WC-1561MM.
0 3.5 7 14 Miles
Mapped Arundo in the Central Valley
Treated*
Not Treated
Central Valley Watershed Unit
Major Rivers / Streams
Counties
*Treatment status is past, present or future, if known.
Acreage of *Arundo donax* in Cottonwood Creek Watershed Unit
Map 2 of 25
Central Valley Arundo: Distribution, Impacts and Management
\\Projects\Arundo\FinalCVArundo Maps Tables\20200310 CV ArundoByWatershed L Portrait.mxd

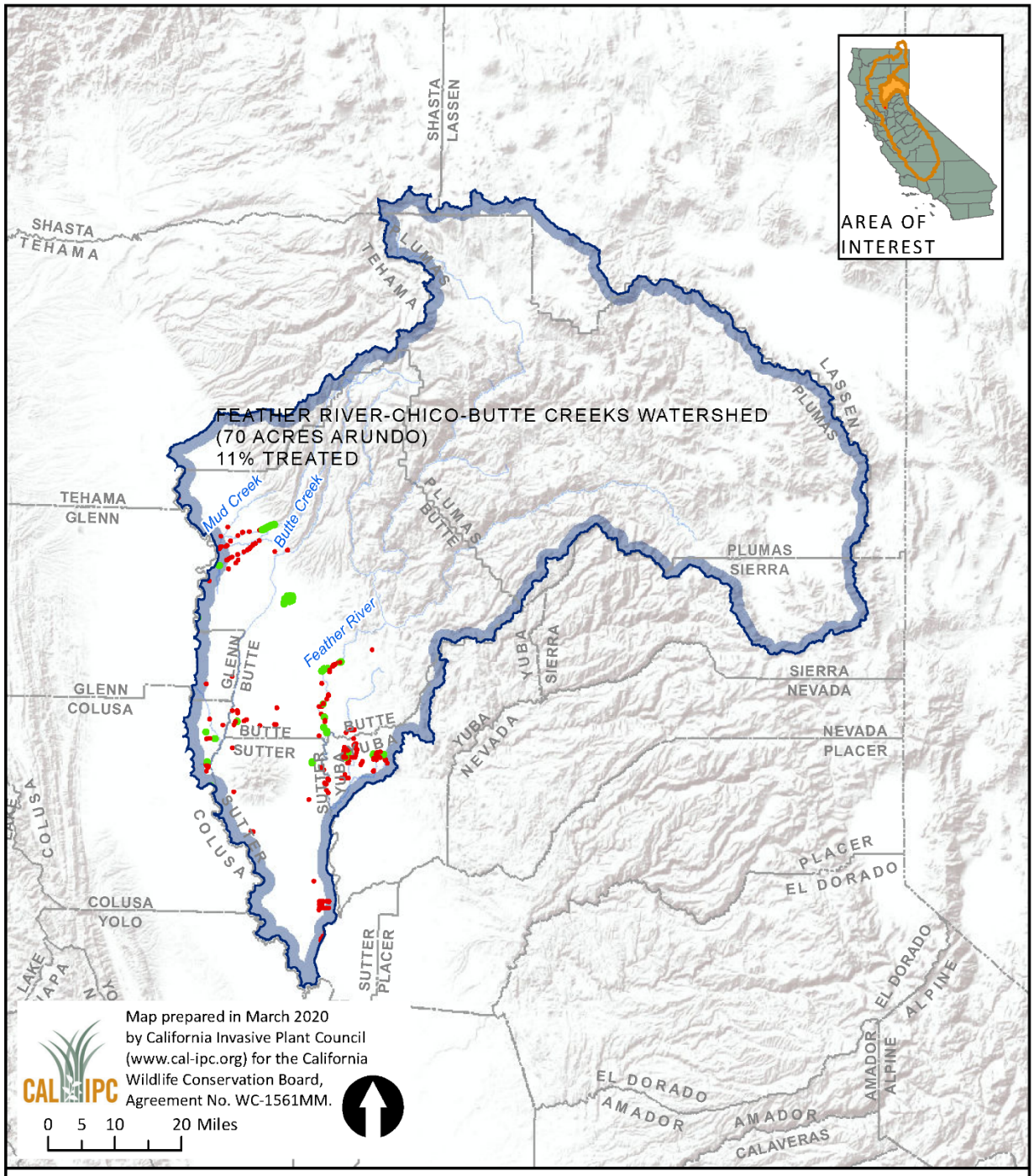

AREA OF INTEREST
TRINITY
SHASTA
TEHAMA
TRINITY
TEHAMA
TEHAMA
Sacramento River
Reeds Creek
Red Bank Creek
ELDER CREEK WATERSHED
(85 ACRES ARUNDO)
11% TREATED
Oat Creek
Elder Creek
Digger Creek
TEHAMA
BUTTE
TEHAMA
GLENN
BUTTE
GLENN
Map prepared in March 2020
by California Invasive Plant Council
(www.cal-ipc.org) for the California
Wildlife Conservation Board,
Agreement No. WC-1561MM.
0 2.75 5.5 11 Miles
Mapped Arundo in the Central Valley
Treated*
Not Treated
Central Valley Watershed Unit
Major Rivers / Streams
Counties
*Treatment status is past, present or future, if known.
Acreage of *Arundo donax* in Elder Creek Watershed Unit
Map 3 of 25
Central Valley Arundo: Distribution, Impacts and Management
\\Projects\Arundo\FinalCVArundo Maps Tables\20200310 CV ArundoByWatershed L Portrait.mxd

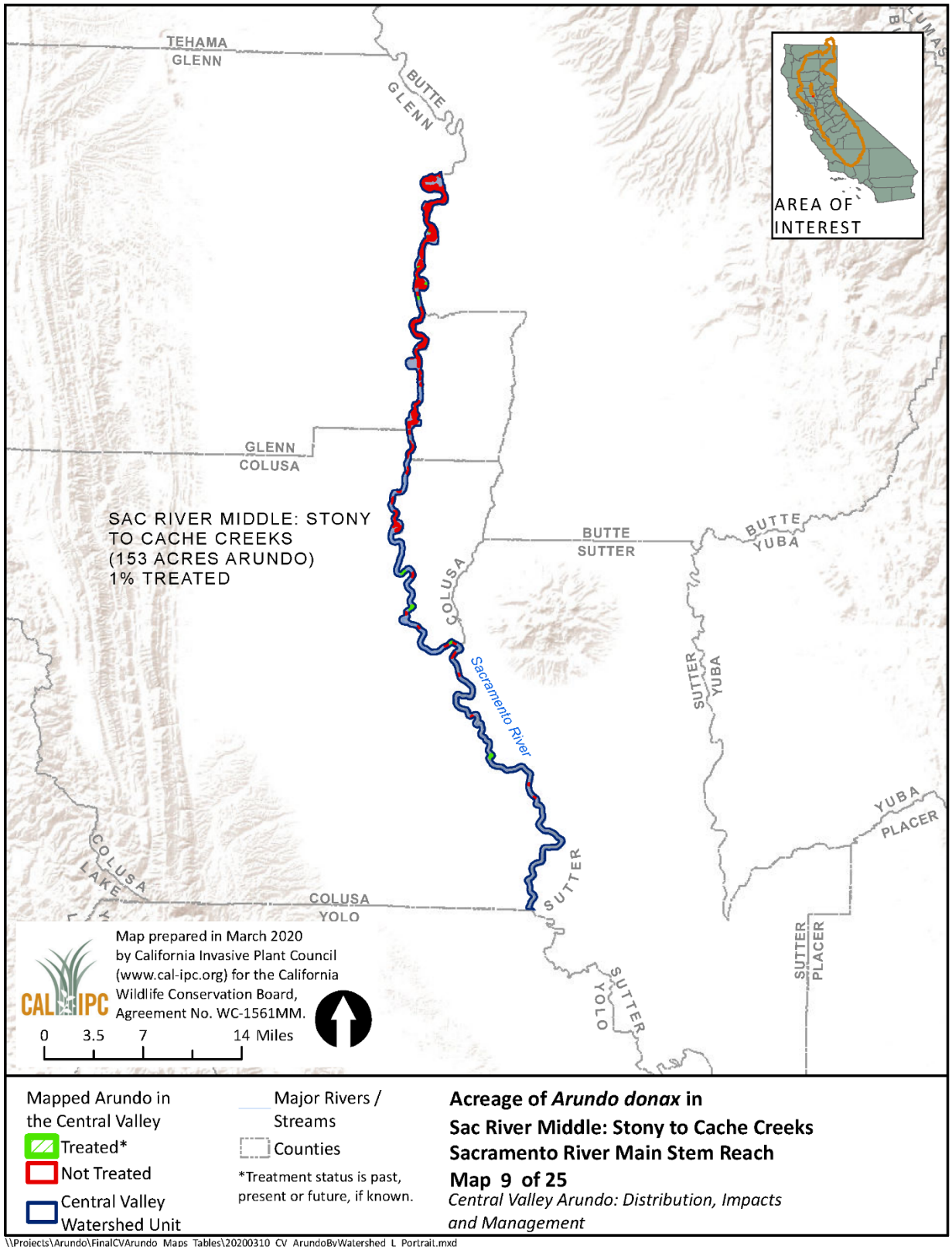

SHASTA
TEHAMA
AREA OF INTEREST
SAC RIVER UPPER: COTTONWOOD TO THOMES CREEKS
(154 ACRES ARUNDO)
0% TREATED
Sacramento River
TEHAMA
BUTTE
TEHAMA
GLENN
BUTTE
GLENN
Map prepared in March 2020 by California Invasive Plant Council (www.cal-ipc.org) for the California Wildlife Conservation Board, Agreement No. WC-1561MM.
0 3.25 6.5 13 Miles
Mapped Arundo in the Central Valley
Treated*
Not Treated
Central Valley Watershed Unit
Major Rivers / Streams
Counties
*Treatment status is past, present or future, if known.
Acreage of *Arundo donax* in
Sac River Upper: Cottonwood to Thomes Creeks
Sacramento River Main Stem Reach
Map 4 of 25
Central Valley Arundo: Distribution, Impacts and Management
\\Projects\Arundo\FinalCVArundo Maps Tables\20200310 CV ArundoByWatershed L Portrait.mxd

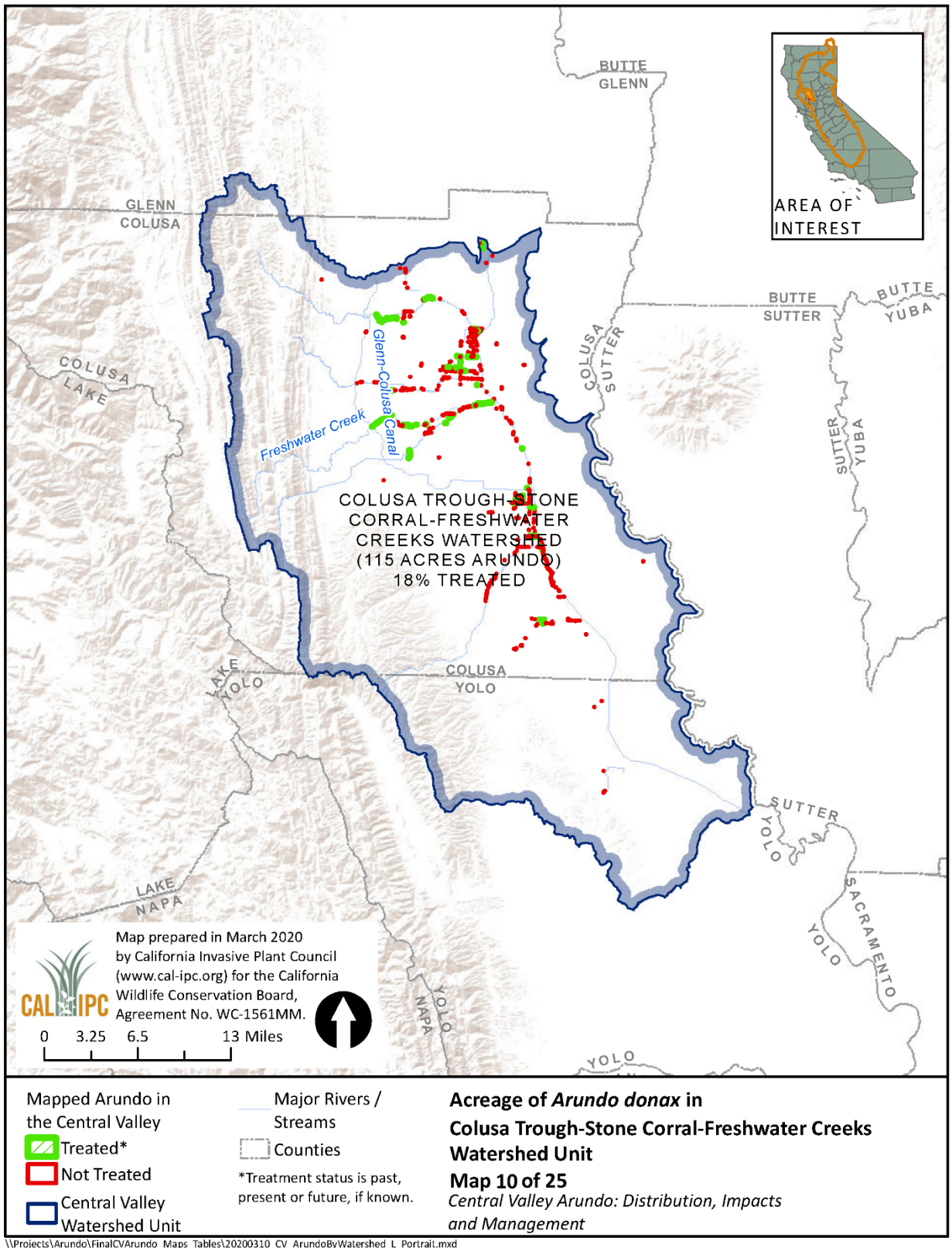

AREA OF INTEREST
SHASTA
TEHAMA
SHASTA
PLUMAS
LASSEN
PLUMAS
PLUMAS
TEHAMA
ANTELOPE-MILL CREEK WATERSHED
(14 ACRES ARUNDO)
0% TREATED
Salt Creek
Long Gulch
Deer Creek
Sacramento River
TEHAMA
BUTTE
TEHAMA
PLUMAS
BUTTE
Map prepared in March 2020
by California Invasive Plant Council
(www.cal-ipc.org) for the California
Wildlife Conservation Board,
Agreement No. WC-1561MM.
0 3.5 7 14 Miles
Mapped Arundo in the Central Valley
Treated*
Not Treated
Central Valley Watershed Unit
Major Rivers / Streams
Counties
*Treatment status is past, present or future, if known.
Acreage of *Arundo donax* in Antelope-Mill Creek Watershed Unit
Map 5 of 25
Central Valley Arundo: Distribution, Impacts and Management
\\Projects\Arundo\FinalCVArundo Maps Tables\20200310 CV ArundoByWatershed L Portrait.mxd

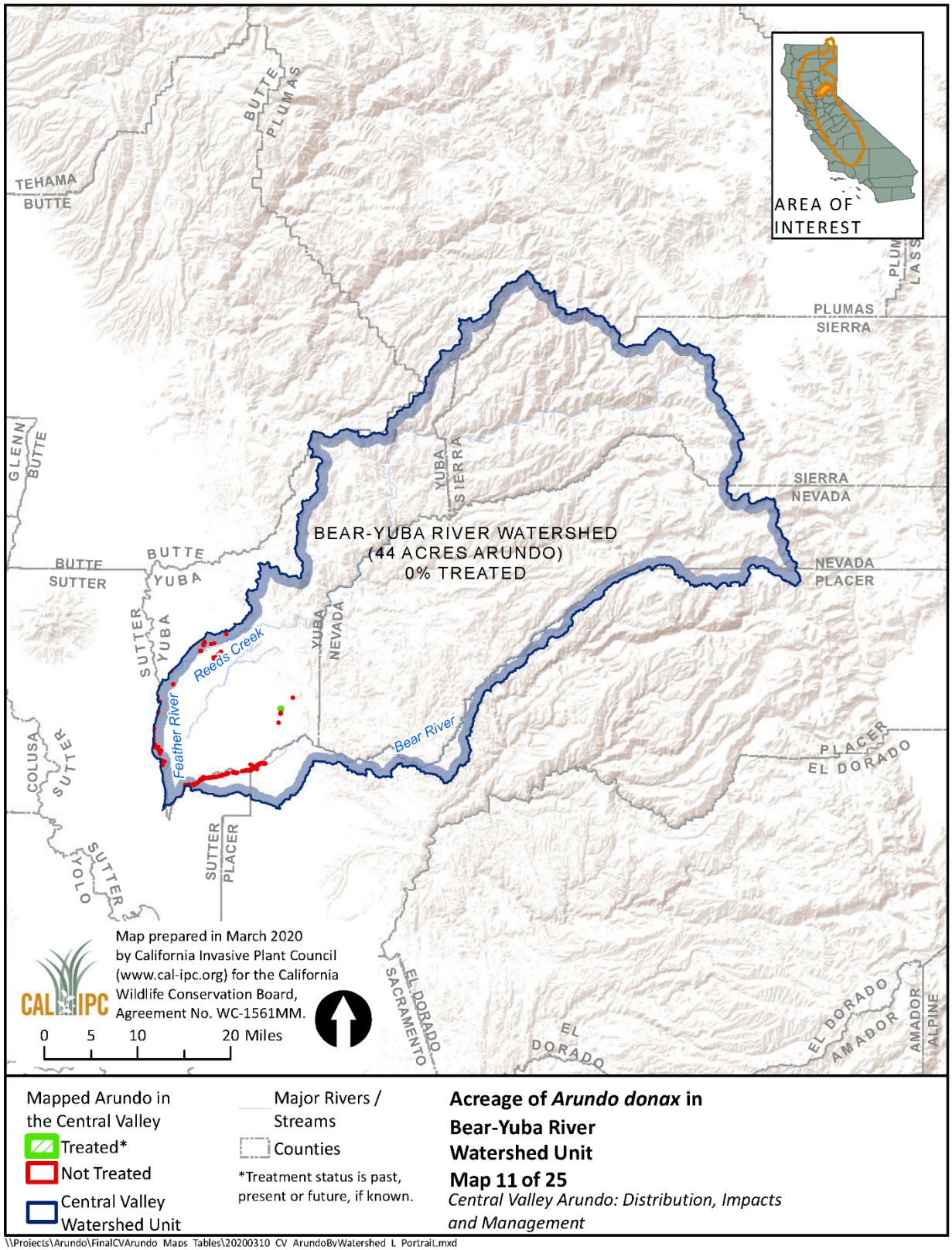

AREA OF INTEREST
THOMES CREEK WATERSHED
(75 ACRES ARUNDO)
6% TREATED
Digger Creek
TRINITY
SHASTA
SHASTA
TEHAMA
TRINITY
TEHAMA
TRINITY
MENDOCINO
MENDOCINO
TEHAMA
TEHAMA
GLENN
MENDOCINO
GLENN
MENDOCINO
LAKE
LAKE
GLENN
TEHAMA
BUTTE
GLENN
COLUSA
GLENN
BUTTE
BUTTE
SUTTER
Map prepared in March 2020
by California Invasive Plant Council
(www.cal-ipc.org) for the California
Wildlife Conservation Board,
Agreement No. WC-1561MM.
0 4 8 16 Miles
Mapped Arundo in the Central Valley
Treated*
Not Treated
Central Valley Watershed Unit
Major Rivers / Streams
Counties
*Treatment status is past, present or future, if known.
Acreage of *Arundo donax* in Thomes Creek Watershed Unit
Map 6 of 25
Central Valley Arundo: Distribution, Impacts and Management
\\Projects\Arundo\FinalCVArundo Maps Tables\20200310 CV ArundoByWatershed L Portrait.mxd

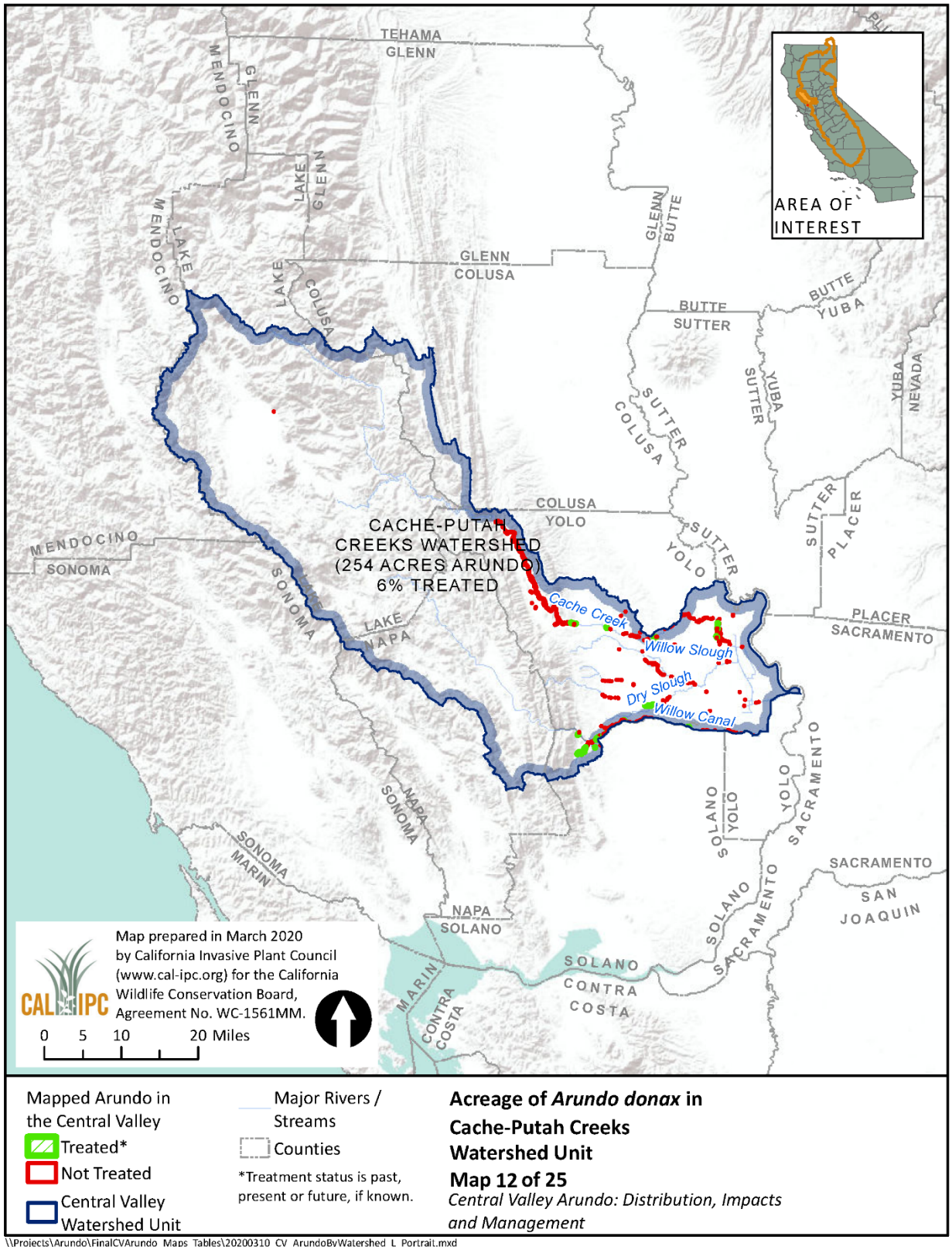

AREA OF INTEREST
STONY CREEK WATERSHED
(562 ACRES ARUNDO)
1% TREATED
Wilson Creek
Glenn-Colusa Canal
Wilson Creek
TRINITY
MENDOCINO
TEHAMA
GLENN
LAKE
BUTTE
SUTTER
COLUSA
Map prepared in March 2020
by California Invasive Plant Council
(www.cal-ipc.org) for the California
Wildlife Conservation Board,
Agreement No. WC-1561MM.
0 3.75 7.5 15 Miles
Mapped Arundo in the Central Valley
Treated*
Not Treated
Central Valley Watershed Unit
Major Rivers / Streams
Counties
*Treatment status is past, present or future, if known.
Acreage of *Arundo donax* in Stony Creek Watershed Unit
Map 7 of 25
Central Valley Arundo: Distribution, Impacts and Management
\\Projects\Arundo\FinalCVArundo Maps Tables\20200310 CV ArundoByWatershed L Portrait.mxd

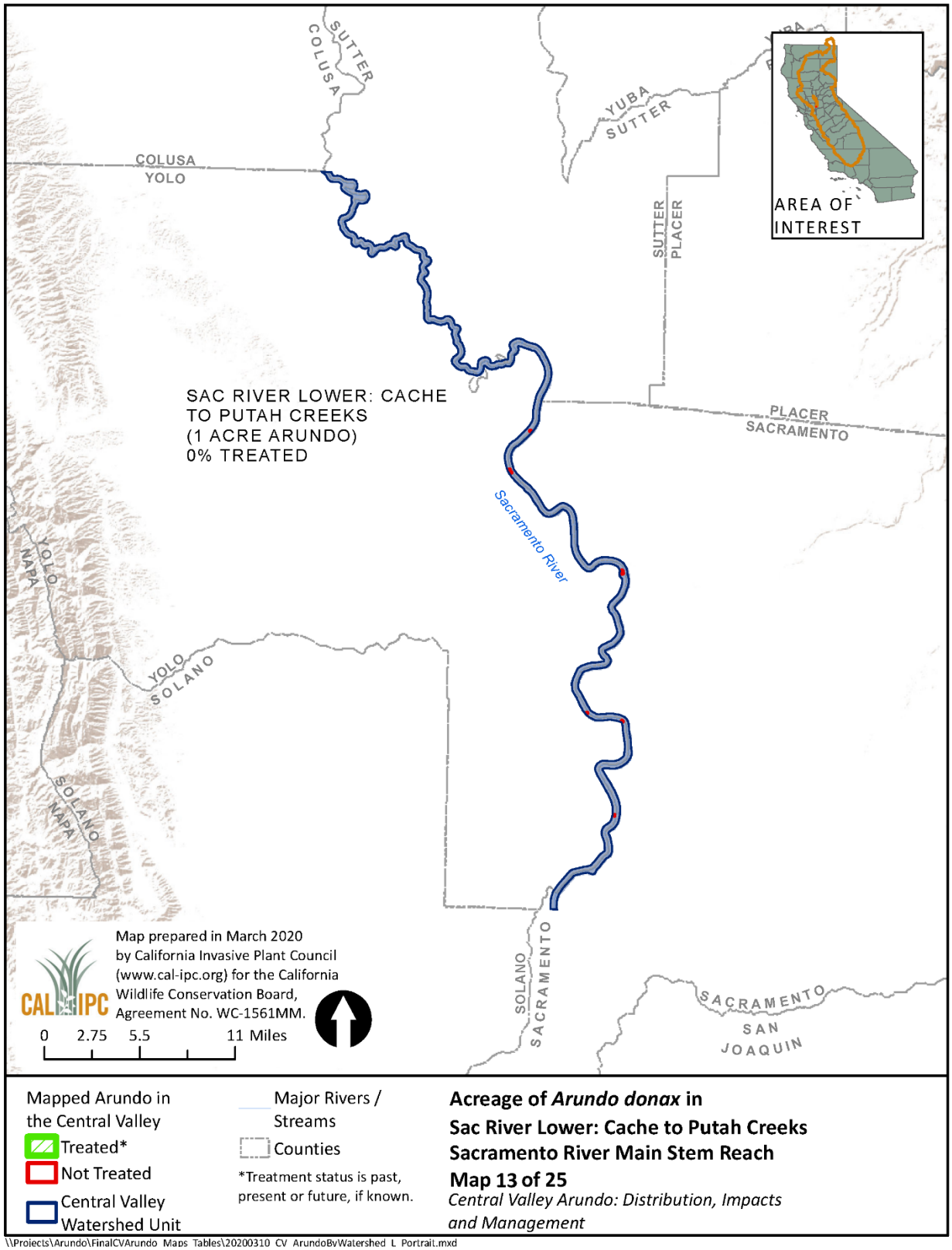

AREA OF INTEREST
FEATHER RIVER-CHICO-BUTTE CREEKS WATERSHED
(70 ACRES ARUNDO)
11% TREATED
Mud Creek
Butte Creek
Feather River
SHASTA
TEHAMA
LASSEN
PLUMAS
SIERRA
NEVADA
PLACER
EL DORADO
ALPINE
AMADOR
CALAVERAS
GLENN
COLUSA
BUTTE
SUTTER
YUBA
YOLO
LAKE
NAPA
SOLANO
Map prepared in March 2020
by California Invasive Plant Council
(www.cal-ipc.org) for the California
Wildlife Conservation Board,
Agreement No. WC-1561MM.
0 5 10 20 Miles
Mapped Arundo in the Central Valley
Treated*
Not Treated
Central Valley Watershed Unit
Major Rivers / Streams
Counties
*Treatment status is past, present or future, if known.
Acreage of *Arundo donax* in Feather River-Chico-Butte Creeks Watershed Unit
Map 8 of 25
Central Valley Arundo: Distribution, Impacts and Management
\\Projects\Arundo\FinalCVArundo Maps Tables\20200310 CV ArundoByWatershed L Portrait.mxd

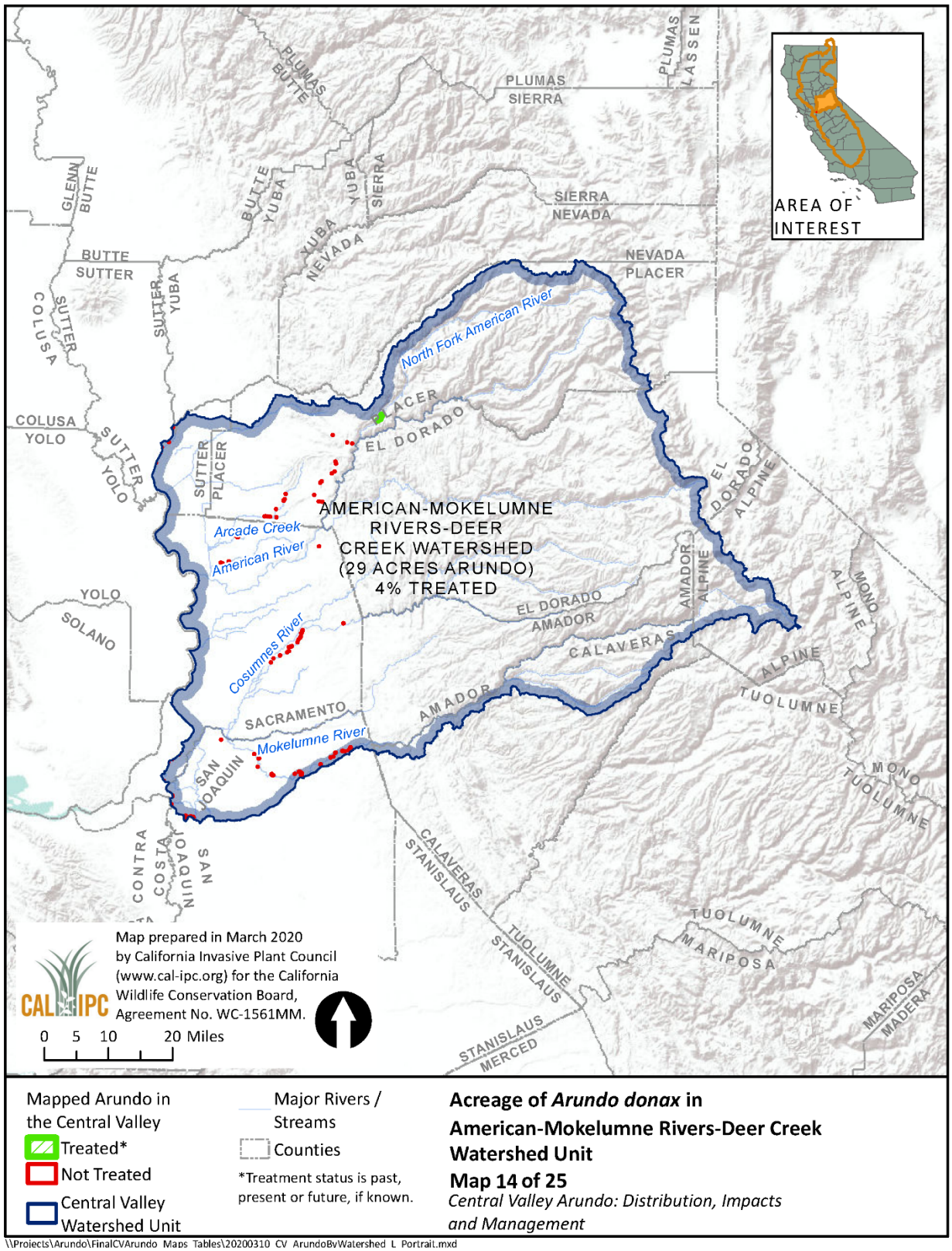

TEHAMA
GLENN
BUTTE
GLENN
AREA OF INTEREST
GLENN
COLUSA
SAC RIVER MIDDLE: STONY TO CACHE CREEKS (153 ACRES ARUNDO) 1% TREATED
BUTTE
SUTTER
BUTTE
YUBA
COLUSA
Sacramento River
SUTTER
YUBA
YUBA
PLACER
COLUSA
LAKE
COLUSA
YOLO
SUTTER
SUTTER
YOLO
SUTTER
PLACER
Map prepared in March 2020 by California Invasive Plant Council (www.cal-ipc.org) for the California Wildlife Conservation Board, Agreement No. WC-1561MM.
0 3.5 7 14 Miles
Mapped Arundo in the Central Valley
Treated*
Not Treated
Central Valley Watershed Unit
Major Rivers / Streams
Counties
*Treatment status is past, present or future, if known.
Acreage of *Arundo donax* in
Sac River Middle: Stony to Cache Creeks
Sacramento River Main Stem Reach
Map 9 of 25
Central Valley Arundo: Distribution, Impacts and Management
\\Projects\Arundo\FinalCVArundo Maps Tables\20200310 CV ArundoByWatershed L Portrait.mxd

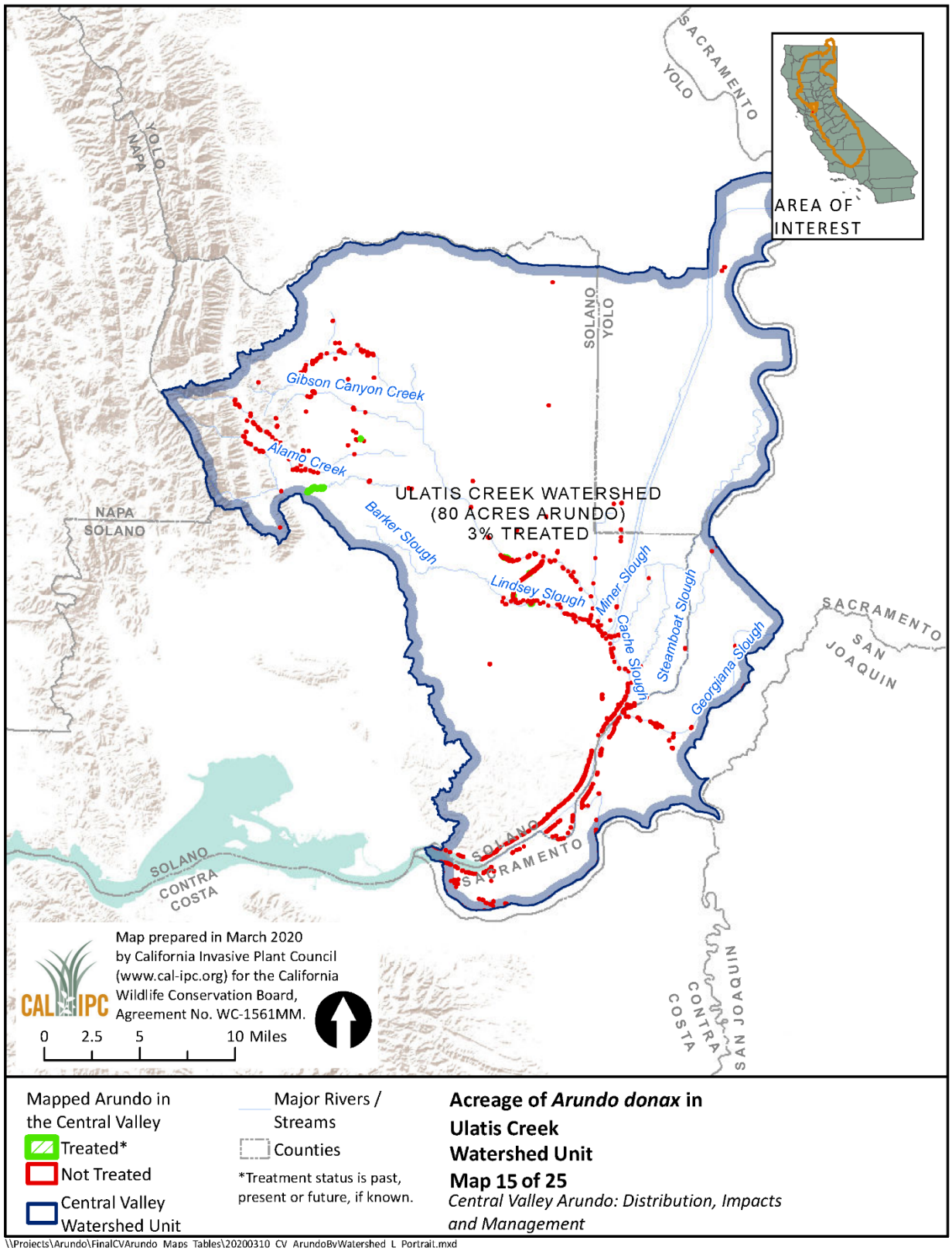

BUTTE
GLENN
AREA OF INTEREST
GLENN
COLUSA
BUTTE
SUTTER
BUTTE
YUBA
COLUSA
SUTTER
COLUSA
LAKE
Glenn-Colusa Canal
Freshwater Creek
SUTTER
YUBA
COLUSA TROUGH-STONE CORRAL-FRESHWATER CREEKS WATERSHED
(115 ACRES ARUNDO)
18% TREATED
LAKE
YOLO
COLUSA
YOLO
SUTTER
YOLO
LAKE
NAPA
SACRAMENTO
YOLO
YOLO
NAPA
YOLO
Map prepared in March 2020
by California Invasive Plant Council
(www.cal-ipc.org) for the California
Wildlife Conservation Board,
Agreement No. WC-1561MM.
0 3.25 6.5 13 Miles
Mapped Arundo in the Central Valley
Treated*
Not Treated
Central Valley Watershed Unit
Major Rivers / Streams
Counties
*Treatment status is past, present or future, if known.
Acreage of *Arundo donax* in
Colusa Trough-Stone Corral-Freshwater Creeks Watershed Unit
Map 10 of 25
Central Valley Arundo: Distribution, Impacts and Management
\\Projects\Arundo\FinalCVArundo Maps Tables\20200310 CV ArundoByWatershed L Portrait.mxd

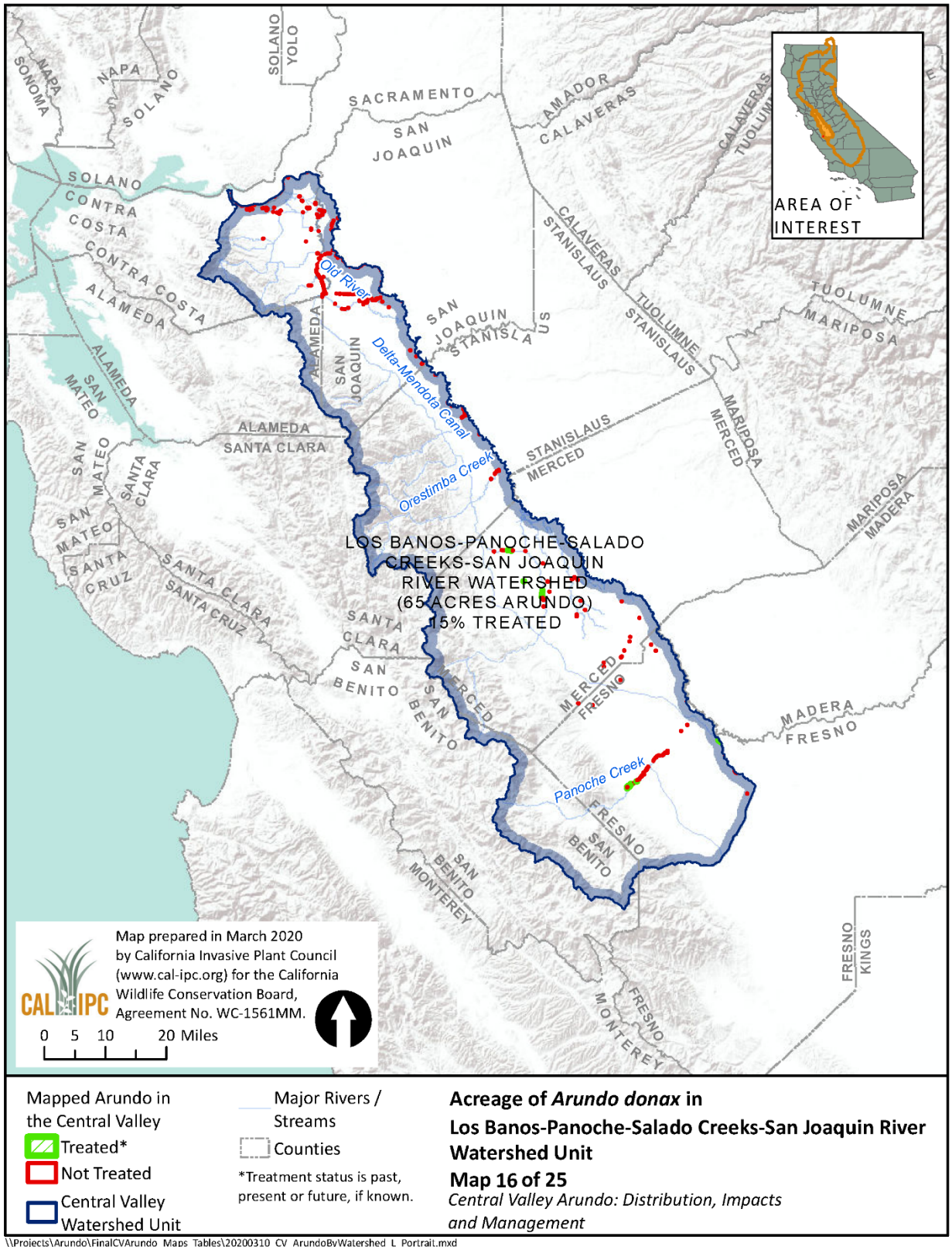

AREA OF INTEREST
BEAR-YUBA RIVER WATERSHED
(44 ACRES ARUNDO)
0% TREATED
Reeds Creek
Feather River
Bear River
TEHAMA
BUTTE
PLUMAS
PLUMAS
SIERRA
SIERRA
NEVADA
NEVADA
PLACER
PLACER
EL DORADO
EL DORADO
AMADOR
ALPINE
SACRAMENTO
GLENN
COLUSA
YOLO
SUTTER
YUBA
Map prepared in March 2020
by California Invasive Plant Council
(www.cal-ipc.org) for the California
Wildlife Conservation Board,
Agreement No. WC-1561MM.
0 5 10 20 Miles
Mapped Arundo in the Central Valley
Treated*
Not Treated
Central Valley Watershed Unit
Major Rivers / Streams
Counties
*Treatment status is past, present or future, if known.
Acreage of *Arundo donax* in Bear-Yuba River Watershed Unit
Map 11 of 25
Central Valley Arundo: Distribution, Impacts and Management
\\Projects\Arundo\FinalCVArundo Maps Tables\20200310 CV ArundoByWatershed L Portrait.mxd

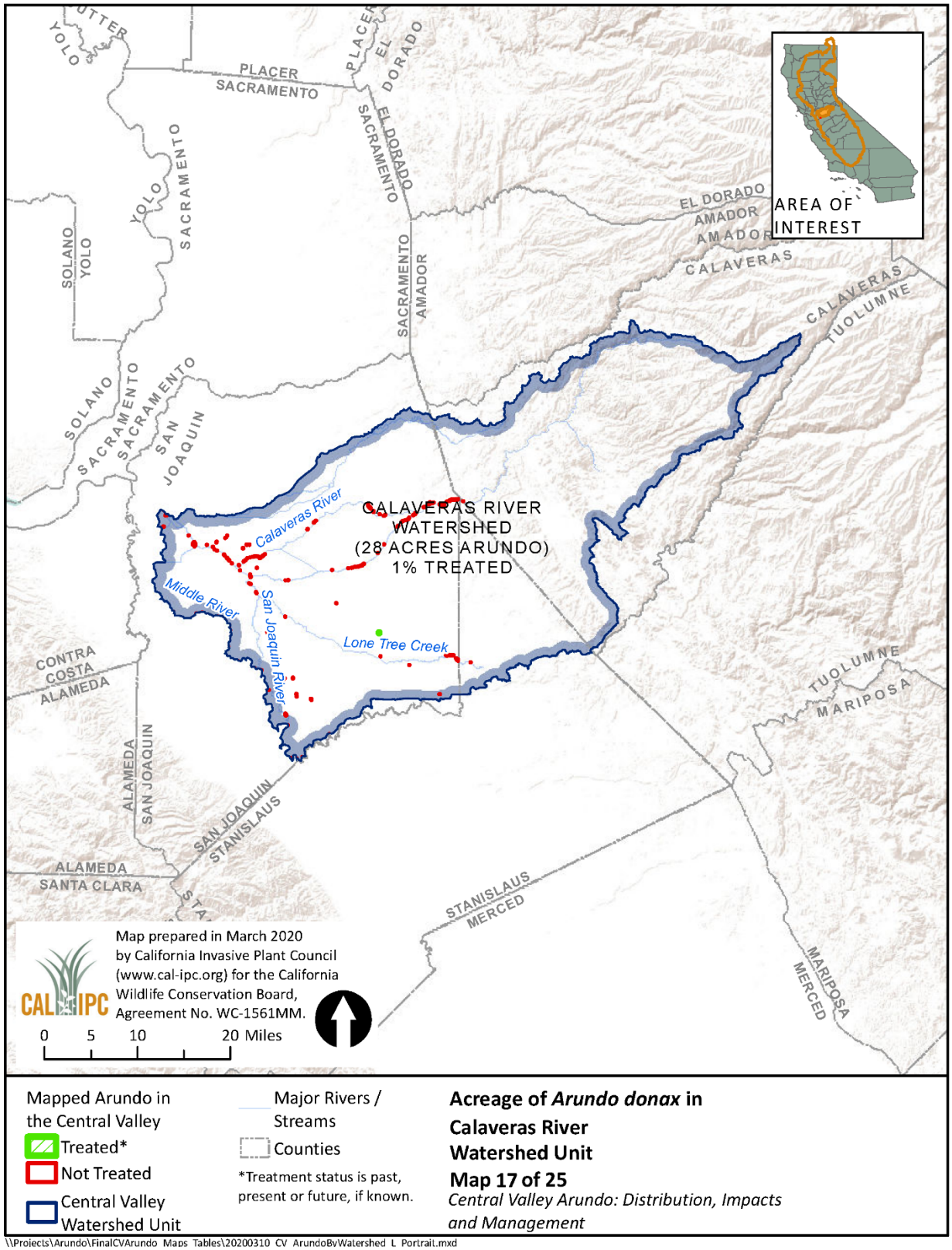

TEHAMA
GLENN
MENDOCINO
GLENN
LAKE
GLENN
MENDOCINO
LAKE
LAKE
COLUSA
GLENN
COLUSA
GLENN
BUTTE
AREA OF INTEREST
BUTTE
SUTTER
BUTTE
YUBA
YUBA
SUTTER
YUBA
NEVADA
SUTTER
COLUSA
SUTTER
COLUSA
YOLO
SUTTER
SUTTER
PLACER
PLACER
SACRAMENTO
CACHE-PUTAH
CREEKS WATERSHED
(254 ACRES ARUNDO)
6% TREATED
Cache Creek
Willow Slough
Dry Slough
Willow Canal
MENDOCINO
SONOMA
SONOMA
LAKE
NAPA
NAPA
SONOMA
SONOMA
MARIN
NAPA
SOLANO
SOLANO
YOLO
YOLO
SACRAMENTO
SOLANO
SACRAMENTO
SACRAMENTO
SAN
JOAQUIN
SOLANO
CONTRA
COSTA
MARIN
CONTRA
COSTA
Map prepared in March 2020
by California Invasive Plant Council
(www.cal-ipc.org) for the California
Wildlife Conservation Board,
Agreement No. WC-1561MM.
0 5 10 20 Miles
Mapped Arundo in
the Central Valley
Treated*
Not Treated
Central Valley
Watershed Unit
Major Rivers /
Streams
Counties
*Treatment status is past,
present or future, if known.
Acreage of *Arundo donax* in
Cache-Putah Creeks
Watershed Unit
Map 12 of 25
*Central Valley Arundo: Distribution, Impacts
and Management*
\\Projects\Arundo\FinalCVArundo Maps Tables\20200310 CV ArundoByWatershed L Portrait.mxd

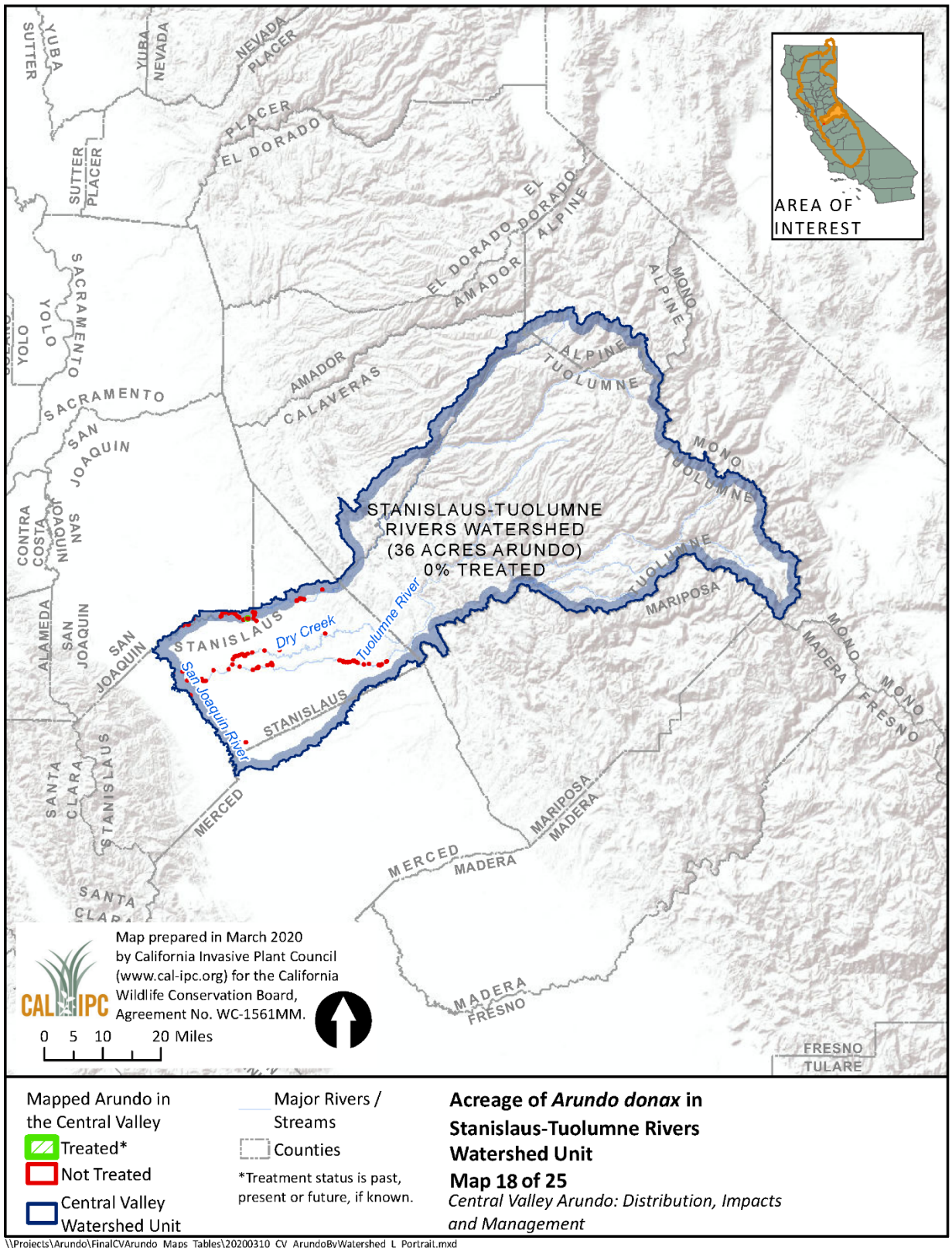

SUTTER
COLUSA
YUBA
SUTTER
COLUSA
YOLO
SUTTER
PLACER
AREA OF
INTEREST
SAC RIVER LOWER: CACHE
TO PUTAH CREEKS
(1 ACRE ARUNDO)
0% TREATED
PLACER
SACRAMENTO
Sacramento River
YOLO
NAPA
YOLO
SOLANO
SOLANO
NAPA
Map prepared in March 2020
by California Invasive Plant Council
(www.cal-ipc.org) for the California
Wildlife Conservation Board,
Agreement No. WC-1561MM.
0 2.75 5.5 11 Miles
SOLANO
SACRAMENTO
SACRAMENTO
SAN
JOAQUIN
Mapped Arundo in
the Central Valley
Treated*
Not Treated
Central Valley
Watershed Unit
Major Rivers /
Streams
Counties
*Treatment status is past,
present or future, if known.
Acreage of *Arundo donax* in
Sac River Lower: Cache to Putah Creeks
Sacramento River Main Stem Reach
Map 13 of 25
*Central Valley Arundo: Distribution, Impacts
and Management*
\\Projects\Arundo\FinalCVArundo Maps Tables\20200310 CV ArundoByWatershed L Portrait.mxd

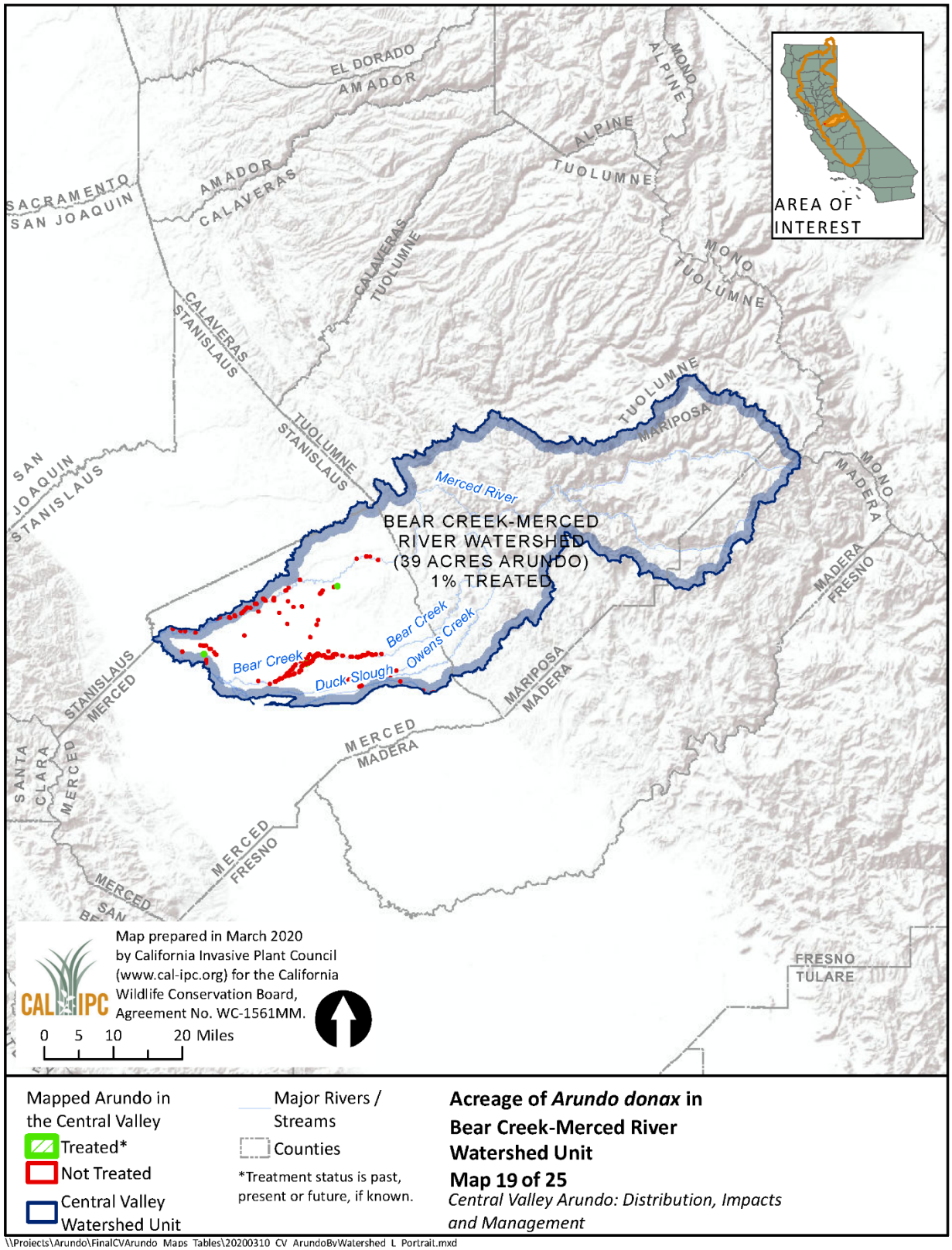

AREA OF INTEREST
AMERICAN-MOKELUMNE RIVERS-DEER CREEK WATERSHED (29 ACRES ARUNDO) 4% TREATED
North Fork American River
Arcade Creek
American River
Cosumnes River
Mokelumne River
PLUMAS
SIERRA
NEVADA
PLACER
EL DORADO
SACRAMENTO
AMADOR
CALAVERAS
TUOLUMNE
ALPINE
MONO
SAN JOAQUIN
STANISLAUS
MERCED
MARIPOSA
MADERA
CONTRA COSTA
SOLANO
YOLO
COLUSA
SUTTER
YUBA
BUTTE
GLENN
LASSEN
Map prepared in March 2020 by California Invasive Plant Council (www.cal-ipc.org) for the California Wildlife Conservation Board, Agreement No. WC-1561MM.
0 5 10 20 Miles
Mapped Arundo in the Central Valley
Treated*
Not Treated
Central Valley Watershed Unit
Major Rivers / Streams
Counties
*Treatment status is past, present or future, if known.
Acreage of *Arundo donax* in American-Mokelumne Rivers-Deer Creek Watershed Unit
Map 14 of 25
Central Valley Arundo: Distribution, Impacts and Management
\\Projects\Arundo\FinalCVArundo Maps Tables\20200310 CV ArundoByWatershed L Portrait.mxd

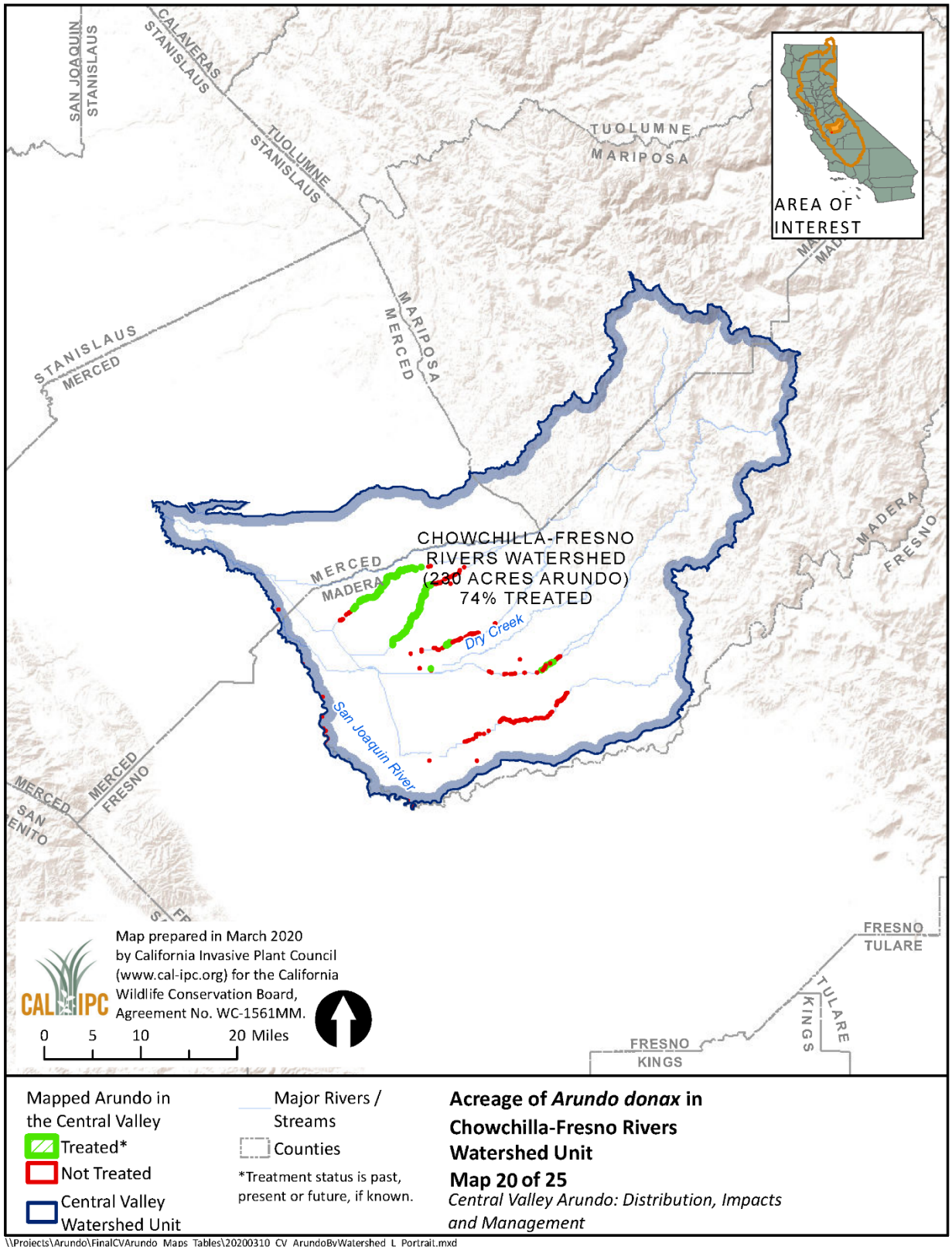

AREA OF INTEREST
ULATIS CREEK WATERSHED
(80 ACRES ARUNDO)
3% TREATED
Gibson Canyon Creek
Alamo Creek
Barker Slough
Lindsey Slough
Miner Slough
Cache Slough
Steamboat Slough
Georgiana Slough
SACRAMENTO
YOLO
NAPA
SOLANO
CONTRA COSTA
SAN JOAQUIN
Map prepared in March 2020
by California Invasive Plant Council
(www.cal-ipc.org) for the California
Wildlife Conservation Board,
Agreement No. WC-1561MM.
0 2.5 5 10 Miles
Mapped Arundo in the Central Valley
Treated*
Not Treated
Central Valley Watershed Unit
Major Rivers / Streams
Counties
*Treatment status is past, present or future, if known.
Acreage of *Arundo donax* in Ulatis Creek Watershed Unit
Map 15 of 25
Central Valley Arundo: Distribution, Impacts and Management
\\Projects\Arundo\FinalCVArundo Maps Tables\20200310 CV ArundoByWatershed L Portrait.mxd

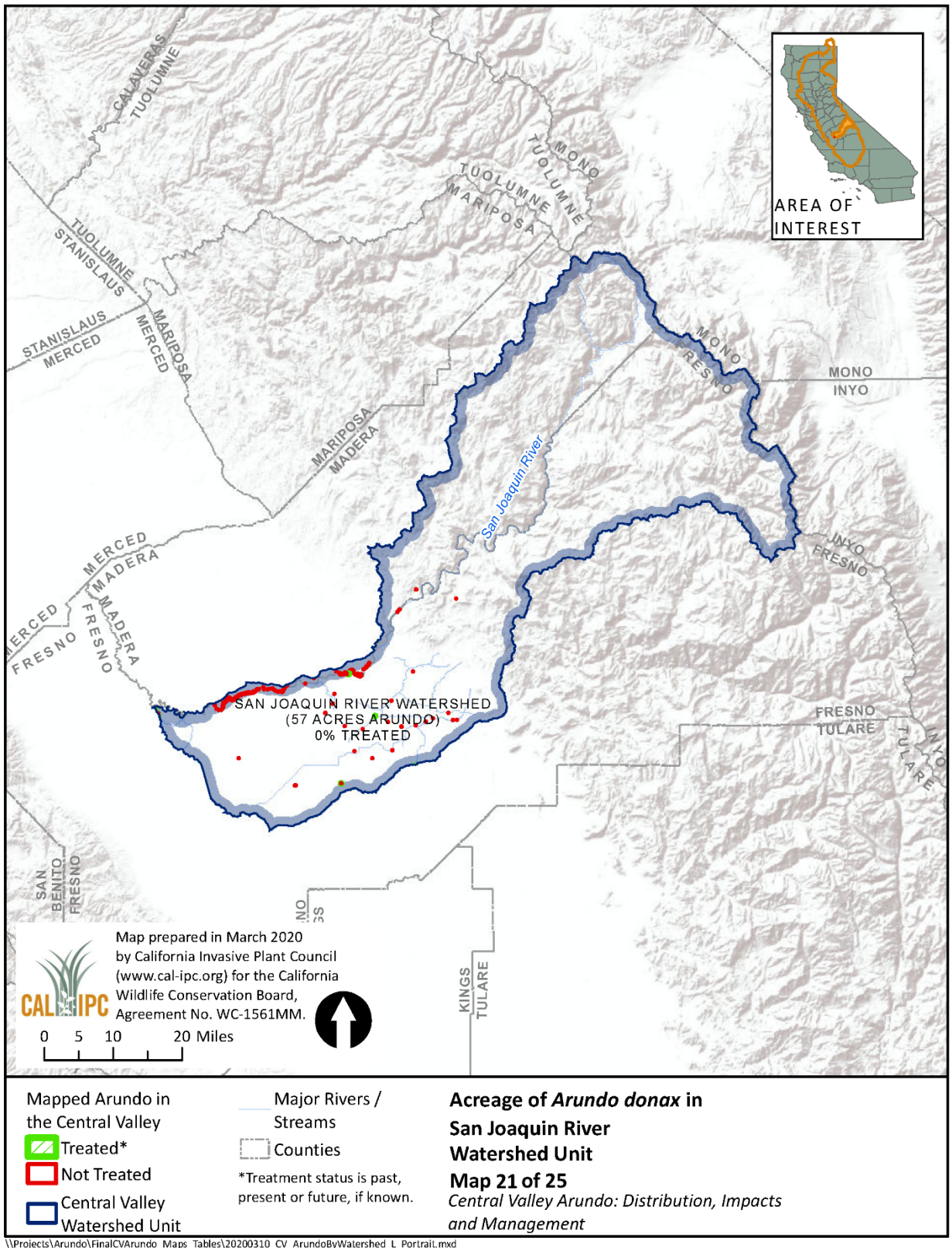

AREA OF INTEREST
LOS BANOS-PANOCHE-SALADO CREEKS-SAN JOAQUIN RIVER WATERSHED
(65 ACRES ARUNDO)
15% TREATED
Old River
Delta-Mendota Canal
Orestimba Creek
Panoche Creek
Map prepared in March 2020 by California Invasive Plant Council (www.cal-ipc.org) for the California Wildlife Conservation Board, Agreement No. WC-1561MM.
0 5 10 20 Miles
Mapped Arundo in the Central Valley
Treated*
Not Treated
Central Valley Watershed Unit
Major Rivers / Streams
Counties
*Treatment status is past, present or future, if known.
Acreage of *Arundo donax* in
Los Banos-Panoche-Salado Creeks-San Joaquin River Watershed Unit
Map 16 of 25
Central Valley Arundo: Distribution, Impacts and Management
\\Projects\Arundo\FinalCVArundo Maps Tables\20200310 CV ArundoByWatershed L Portrait.mxd

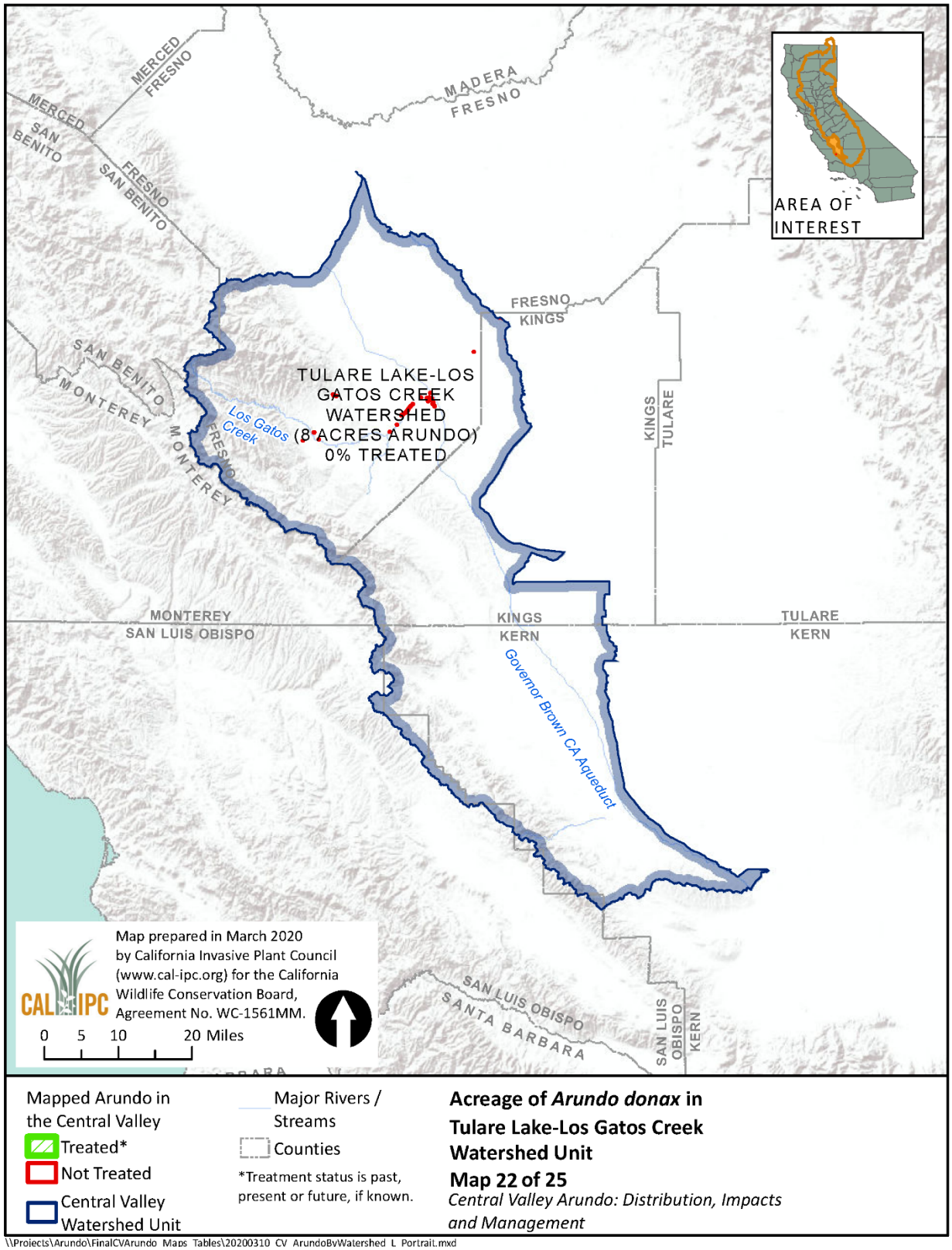

AREA OF INTEREST
CALAVERAS RIVER WATERSHED
(28 ACRES ARUNDO)
1% TREATED
Calaveras River
Middle River
San Joaquin River
Lone Tree Creek
PLACER
SACRAMENTO
EL DORADO
AMADOR
CALAVERAS
TUOLUMNE
MARIPOSA
MERCED
STANISLAUS
SAN JOAQUIN
ALAMEDA
CONTRA COSTA
SANTA CLARA
SOLANO
YOLO
SUTTER
Map prepared in March 2020
by California Invasive Plant Council
(www.cal-ipc.org) for the California
Wildlife Conservation Board,
Agreement No. WC-1561MM.
0 5 10 20 Miles
Mapped Arundo in the Central Valley
Treated*
Not Treated
Central Valley Watershed Unit
Major Rivers / Streams
Counties
*Treatment status is past, present or future, if known.
Acreage of *Arundo donax* in Calaveras River Watershed Unit
Map 17 of 25
Central Valley Arundo: Distribution, Impacts and Management
\\Projects\Arundo\FinalCVArundo Maps Tables\20200310 CV ArundoByWatershed L Portrait.mxd

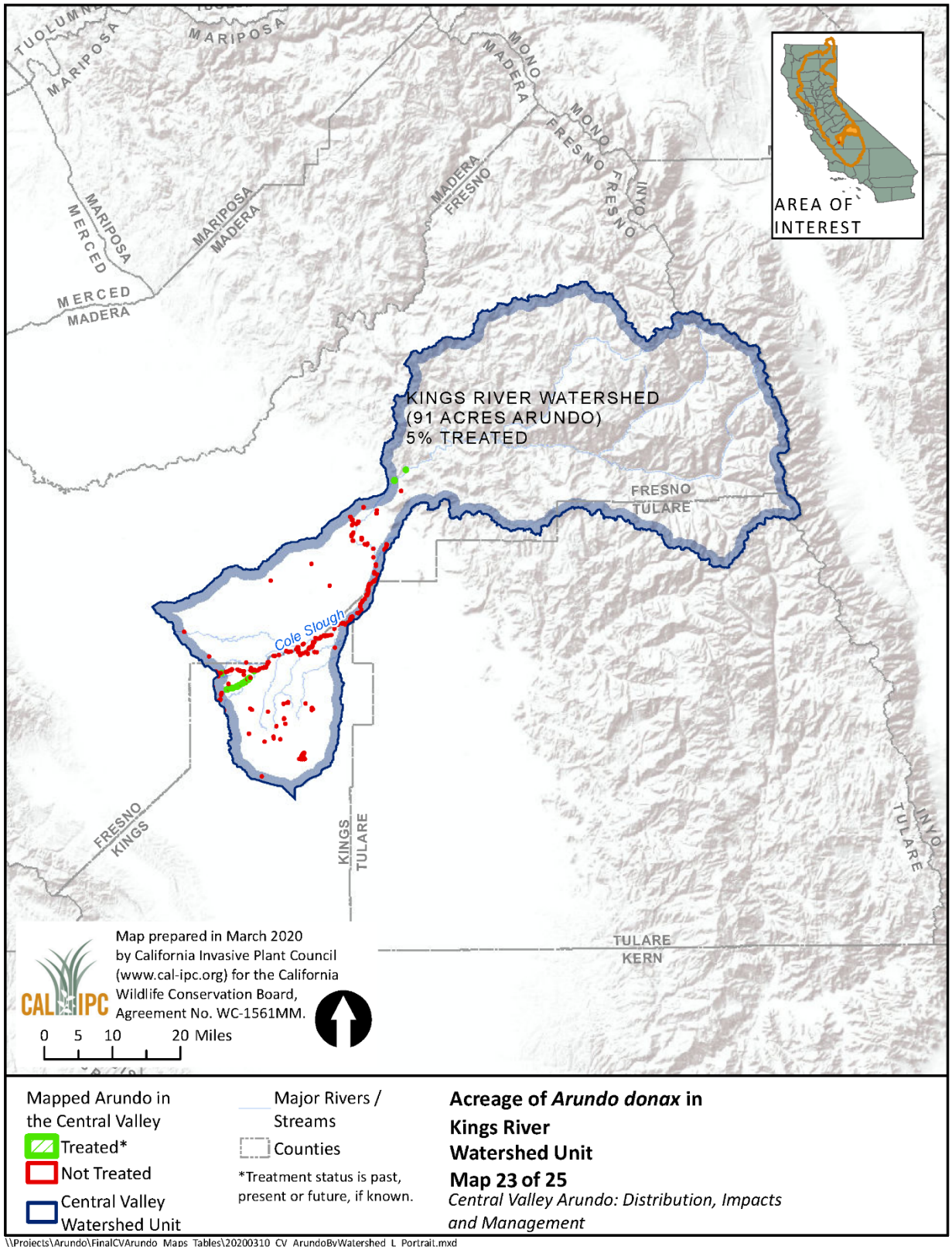

AREA OF INTEREST
STANISLAUS-TUOLUMNE RIVERS WATERSHED (36 ACRES ARUNDO) 0% TREATED
Dry Creek
Tuolumne River
San Joaquin River
SUTTER
YUBA
NEVADA
PLACER
EL DORADO
ALPINE
AMADOR
SACRAMENTO
YOLO
CALAVERAS
TUOLUMNE
MONO
SAN JOAQUIN
CONTRA COSTA
ALAMEDA
STANISLAUS
MARIPOSA
MADERA
FRESNO
MERCED
SANTA CLARA
TULARE
Map prepared in March 2020 by California Invasive Plant Council (www.cal-ipc.org) for the California Wildlife Conservation Board, Agreement No. WC-1561MM.
0 5 10 20 Miles
Mapped Arundo in the Central Valley
Treated*
Not Treated
Central Valley Watershed Unit
Major Rivers / Streams
Counties
*Treatment status is past, present or future, if known.
Acreage of *Arundo donax* in Stanislaus-Tuolumne Rivers Watershed Unit
Map 18 of 25
Central Valley Arundo: Distribution, Impacts and Management
\\Projects\Arundo\FinalCVArundo Maps Tables\20200310 CV ArundoByWatershed L Portrait.mxd

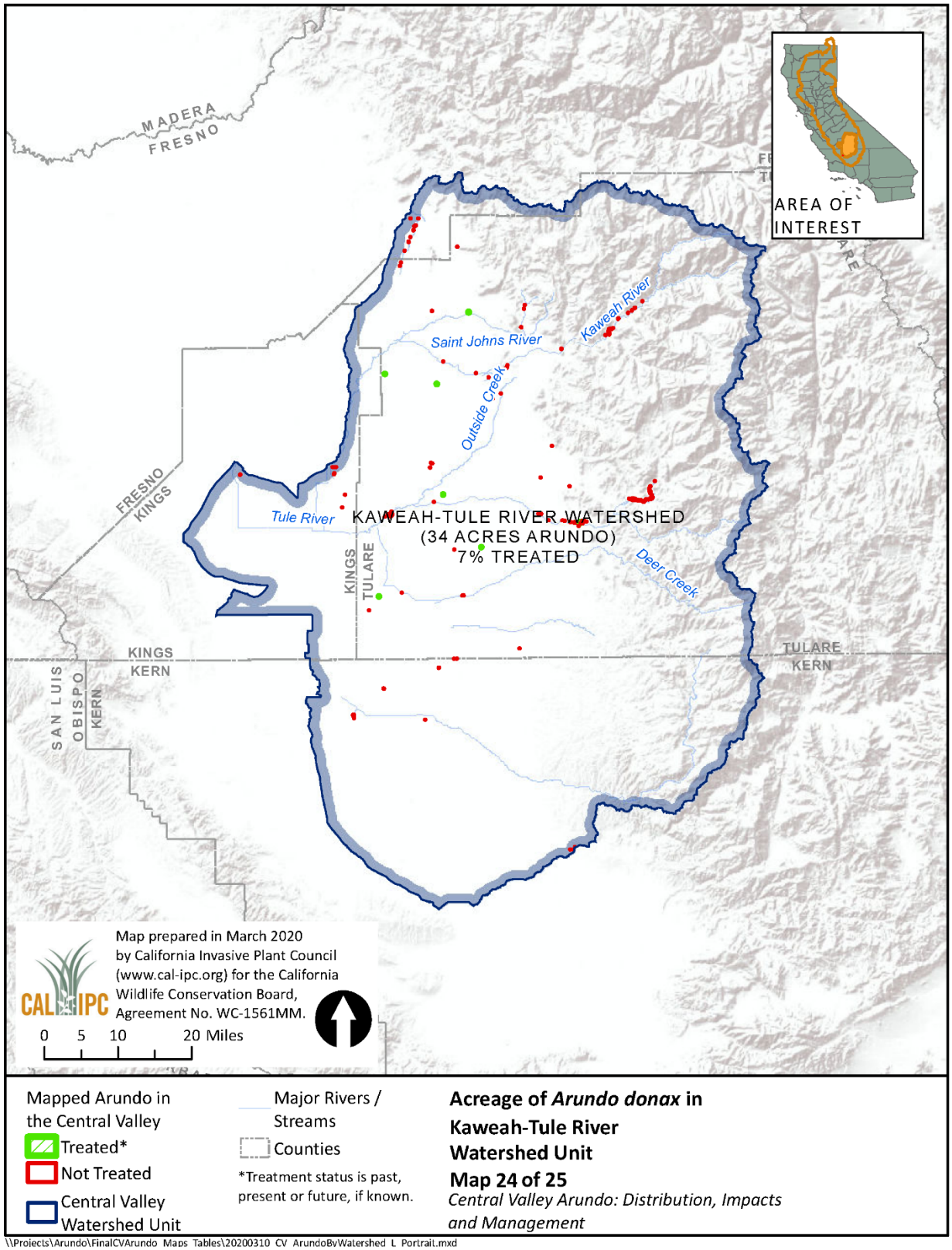

EL DORADO
AMADOR
MONO
ALPINE
ALPINE
TUOLUMNE
AMADOR
CALAVERAS
SACRAMENTO
SAN JOAQUIN
CALAVERAS
TUOLUMNE
MONO
TUOLUMNE
CALAVERAS
STANISLAUS
TUOLUMNE
MARIPOSA
TUOLUMNE
STANISLAUS
SAN
JOAQUIN
STANISLAUS
Merced River
BEAR CREEK-MERCED
RIVER WATERSHED
(39 ACRES ARUNDO)
1% TREATED
MONO
MADERA
MADERA
FRESNO
Bear Creek
Owens Creek
Bear Creek
Duck Slough
STANISLAUS
MERCED
MARIPOSA
MADERA
SANTA
CLARA
MERCED
MERCED
MADERA
MERCED
FRESNO
MERCED
SAN
FRESNO
TULARE
AREA OF
INTEREST
Map prepared in March 2020
by California Invasive Plant Council
(www.cal-ipc.org) for the California
Wildlife Conservation Board,
Agreement No. WC-1561MM.
0 5 10 20 Miles
Mapped Arundo in
the Central Valley
Treated*
Not Treated
Central Valley
Watershed Unit
Major Rivers /
Streams
Counties
*Treatment status is past,
present or future, if known.
Acreage of *Arundo donax* in
Bear Creek-Merced River
Watershed Unit
Map 19 of 25
*Central Valley Arundo: Distribution, Impacts
and Management*
\\Projects\Arundo\FinalCVArundo Maps Tables\20200310 CV ArundoByWatershed L Portrait.mxd

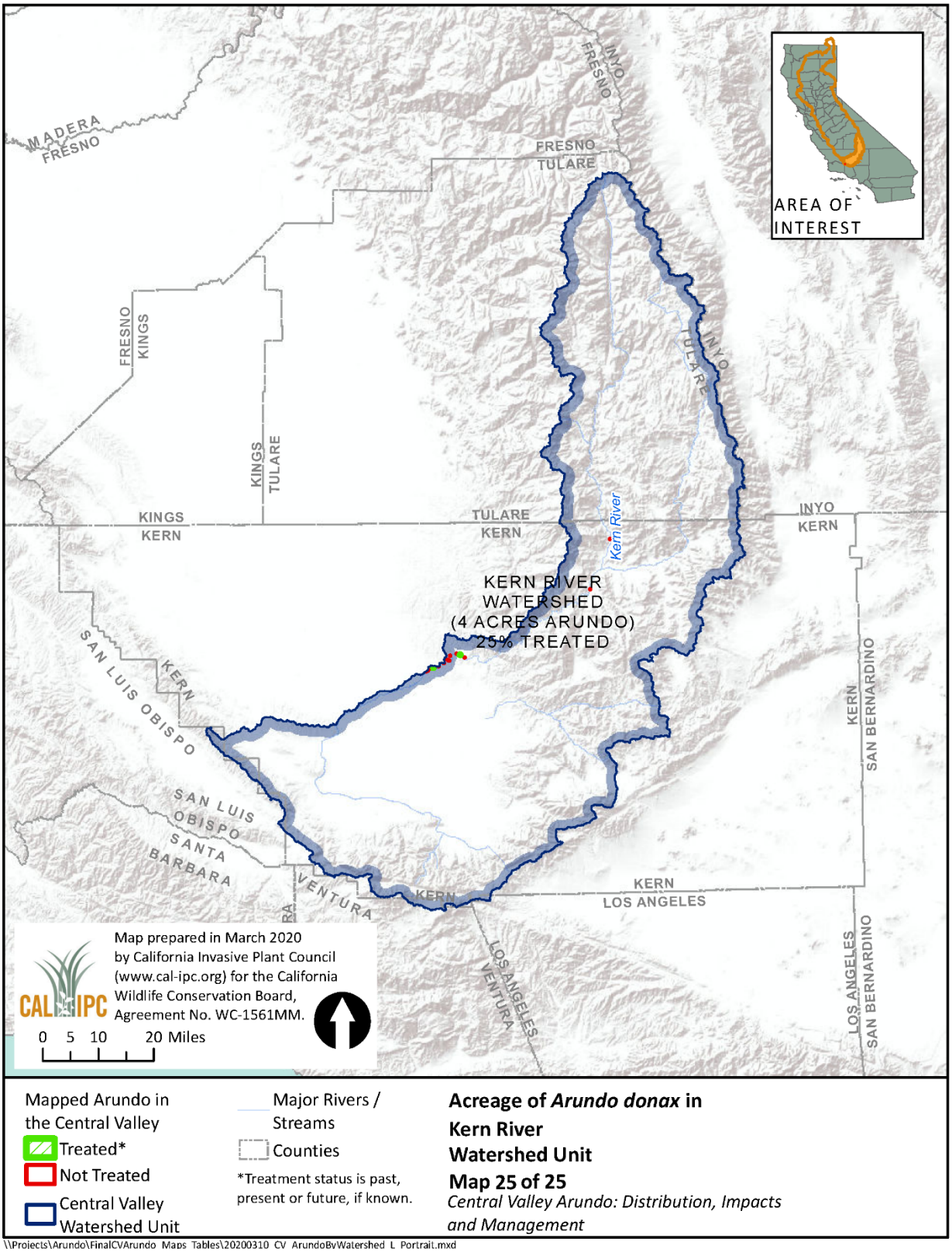

SAN JOAQUIN
STANISLAUS
CALAVERAS
STANISLAUS
TUOLUMNE
STANISLAUS
TUOLUMNE
MARIPOSA
AREA OF
INTEREST
STANISLAUS
MERCED
MARIPOSA
MERCED
CHOWCHILLA-FRESNO
RIVERS WATERSHED
(230 ACRES ARUNDO)
74% TREATED
MERCED
MADERA
Dry Creek
San Joaquin River
MADERA
FRESNO
MERCED
MERCED
FRESNO
MERCED
SAN
BENITO
FRESNO
TULARE
FRESNO
KINGS
TULARE
KINGS
Map prepared in March 2020
by California Invasive Plant Council
(www.cal-ipc.org) for the California
Wildlife Conservation Board,
Agreement No. WC-1561MM.
0 5 10 20 Miles
Mapped Arundo in
the Central Valley
Treated*
Not Treated
Central Valley
Watershed Unit
Major Rivers /
Streams
Counties
*Treatment status is past,
present or future, if known.
Acreage of *Arundo donax* in
Chowchilla-Fresno Rivers
Watershed Unit
Map 20 of 25
*Central Valley Arundo: Distribution, Impacts
and Management*
\\Projects\Arundo\FinalCVArundo Maps Tables\20200310 CV ArundoByWatershed L Portrait.mxd


AREA OF INTEREST
SAN JOAQUIN RIVER WATERSHED
(57 ACRES ARUNDO)
0% TREATED
San Joaquin River
CALAVERAS
TUOLUMNE
MONO
MARIPOSA
STANISLAUS
MERCED
MADERA
FRESNO
INYO
KINGS
TULARE
SAN BENITO
Map prepared in March 2020
by California Invasive Plant Council
(www.cal-ipc.org) for the California
Wildlife Conservation Board,
Agreement No. WC-1561MM.
0 5 10 20 Miles
Mapped Arundo in the Central Valley
Treated*
Not Treated
Central Valley Watershed Unit
Major Rivers / Streams
Counties
*Treatment status is past, present or future, if known.
Acreage of *Arundo donax* in San Joaquin River Watershed Unit
Map 21 of 25
Central Valley Arundo: Distribution, Impacts and Management
\\Projects\Arundo\FinalCVArundo Maps Tables\20200310 CV ArundoByWatershed L Portrait.mxd


MERCED
FRESNO
MADERA
FRESNO
MERCED
SAN BENITO
FRESNO
SAN BENITO
AREA OF INTEREST
FRESNO
KINGS
SAN BENITO
MONTEREY
TULARE LAKE-LOS GATOS CREEK WATERSHED (8 ACRES ARUNDO) 0% TREATED
Los Gatos Creek
FRESNO
MONTEREY
KINGS
TULARE
MONTEREY
SAN LUIS OBISPO
KINGS
KERN
TULARE
KERN
Governor Brown CA Aqueduct
SAN LUIS OBISPO
SANTA BARBARA
SAN LUIS OBISPO
KERN
Map prepared in March 2020
by California Invasive Plant Council
(www.cal-ipc.org) for the California
Wildlife Conservation Board,
Agreement No. WC-1561MM.
0 5 10 20 Miles
Mapped Arundo in the Central Valley
Treated*
Not Treated
Central Valley Watershed Unit
Major Rivers / Streams
Counties
*Treatment status is past, present or future, if known.
Acreage of *Arundo donax* in Tulare Lake-Los Gatos Creek Watershed Unit
Map 22 of 25
Central Valley Arundo: Distribution, Impacts and Management
\\Projects\Arundo\FinalCVArundo Maps Tables\20200310 CV ArundoByWatershed L Portrait.mxd


AREA OF INTEREST
KINGS RIVER WATERSHED
(91 ACRES ARUNDO)
5% TREATED
Cole Slough
TUOLUMNE
MARIPOSA
MERCED
MADERA
FRESNO
TULARE
KINGS
INYO
KERN
MONO
Map prepared in March 2020
by California Invasive Plant Council
(www.cal-ipc.org) for the California
Wildlife Conservation Board,
Agreement No. WC-1561MM.
0 5 10 20 Miles
Mapped Arundo in the Central Valley
Treated*
Not Treated
Central Valley Watershed Unit
Major Rivers / Streams
Counties
*Treatment status is past, present or future, if known.
Acreage of *Arundo donax* in Kings River Watershed Unit
Map 23 of 25
Central Valley Arundo: Distribution, Impacts and Management
\\Projects\Arundo\FinalCVArundo Maps Tables\20200310 CV ArundoByWatershed L Portrait.mxd


MADERA
FRESNO
AREA OF INTEREST
Kaweah River
Saint Johns River
Outside Creek
Tule River
KAWEAH-TULE RIVER WATERSHED
(34 ACRES ARUNDO)
7% TREATED
Deer Creek
FRESNO
KINGS
KINGS
TULARE
KINGS
KERN
TULARE
KERN
SAN LUIS OBISPO
KERN
Map prepared in March 2020
by California Invasive Plant Council
(www.cal-ipc.org) for the California
Wildlife Conservation Board,
Agreement No. WC-1561MM.
0 5 10 20 Miles
Mapped Arundo in the Central Valley
Treated*
Not Treated
Central Valley Watershed Unit
Major Rivers / Streams
Counties
*Treatment status is past, present or future, if known.
Acreage of *Arundo donax* in Kaweah-Tule River Watershed Unit
Map 24 of 25
Central Valley Arundo: Distribution, Impacts and Management
\\Projects\Arundo\FinalCVArundo Maps Tables\20200310 CV ArundoByWatershed L Portrait.mxd


AREA OF INTEREST
KERN RIVER WATERSHED
(4 ACRES ARUNDO)
25% TREATED
Kern River
MADERA
FRESNO
FRESNO
TULARE
INYO
FRESNO
KINGS
KINGS
TULARE
TULARE
INYO
KINGS
KERN
TULARE
KERN
INYO
KERN
SAN LUIS OBISPO
KERN
SAN LUIS OBISPO
SANTA BARBARA
VENTURA
KERN
KERN
LOS ANGELES
KERN
SAN BERNARDINO
LOS ANGELES
VENTURA
LOS ANGELES
SAN BERNARDINO
Map prepared in March 2020
by California Invasive Plant Council
(www.cal-ipc.org) for the California
Wildlife Conservation Board,
Agreement No. WC-1561MM.
0 5 10 20 Miles
Mapped Arundo in the Central Valley
Treated*
Not Treated
Central Valley Watershed Unit
Major Rivers / Streams
Counties
*Treatment status is past, present or future, if known.
Acreage of *Arundo donax* in Kern River Watershed Unit
Map 25 of 25
Central Valley Arundo: Distribution, Impacts and Management
\\Projects\Arundo\FinalCVArundo Maps Tables\20200310 CV ArundoByWatershed L Portrait.mxd

Appendix B – Sensitive Species Accounts

Tricolored blackbird (*Agelaius tricolor*)

Federal status: Candidate (finding posted 8-15-2019)

State status: Threatened

IUCN status: Endangered

Arundo impact score: 4/10 (Low/moderate impact)

Minor alteration of biological function (impacts on general ecological needs, reproduction, diet, or movement).

General Ecological Needs/Habitat Affinities:

Tricolored blackbird is a colonially breeding wetland bird species that is in endemic to California and Baja California, with its center of distribution in the Central Valley. Colonies that require large foraging areas and nesting is restricted to wetland and wetland-adjacent habitats: most colonies forage within 1.5 km of nest sites but some forage up to 6 km. Present-day suitable foraging habitat includes irrigated pasture, dry rangeland and dairy operations. A patchwork of habitats can accommodate a breeding colony. Birds nest in freshwater marshes and croplands. The dominant nest substrate species is cattail (*Typha latifolia*), but also bulrushes (*Scirpus spp.*), blackberries (*Rubus spp.*), mustards (*Brassica spp.*), nettles (*Urtica sp.*), thistles (*Cirsium* and *Centaurea spp.*) and willows (*Salix spp.*).

***Arundo* impacts:** *Arundo* stands may impact nest sites and movement between nest sites and foraging areas. *Arundo* can co-occur and displace one of the preferred nesting substrate species, blackberry, which typically occurs in riparian habitat mixed with native trees. *Arundo* does not typically flourish in marsh wetlands, dominated by cattails and rushes, but frequently occurs on marsh edges. *Arundo* may also invade into ecotonal areas between marsh and riparian area, interfering with marsh vegetation expansion and contraction in response to variation in rainfall. It is possible that *Arundo* could invade marsh habitat during droughts, type-converting marginal marsh habitat.

Breeding/Life History:

Nest height is from 0-3m, but typically 0.5-1.5m. Height of nest planta is up to 5 or more meters, as in oaks, ashes, willows, but typically below canopy is in emergent marsh vegetation and copses of blackberries. The nest is a shallow, open-cup, mud-lined nest of vegetation woven tightly around stem supports and constructed on a created platform in spinous or flooded vegetation. The nest is usually sheltered under overhanging vegetation.

Predators include black-crowned night heron (*Nycticorax nycticorax*) in emergent marsh colonies and especially in refuges, coyotes especially in the Central Valley, ravens, and raccoons. Harriers may harry colonies incessantly, imposing a reproductive cost.

***Arundo* impacts:** *Arundo* stands may impact nest availability and movement between nest sites and foraging areas. *Arundo* can co-occur and displace one of the preferred nesting substrate species, blackberry, which typically occurs in riparian habitat mixed with native trees. *Arundo* does not have a structure that supports nests. *Arundo* does not typically flourish in marsh wetlands, dominated by cattails and rushes, but instead occurs on marsh edges. *Arundo* stands do not afford the same protection from predators as rushes/cattails as *Arundo* stands do not grow in standing water. *Arundo* may expand into wetlands as they dry out (from water use or drought) creating more connectivity between wetland and upland areas that would increase access for coyotes.

Diet:

Tricolored blackbirds opportunistically respond to insect abundance, thriving on grasshopper and other insect outbreaks. During Spring (pre-breeding foraging) they generally consume grains associated with dairy feedlots, cracked corn, sprouting rice, ripening oats and milk barley. During the breeding season they are opportunistic foragers of any insect resources which makes up most of the nestling and fledgling's diets. Post breeding and fall foraging is generally on agricultural cropland such as alfalfa and rice, and grasslands and irrigated pasture.

***Arundo* impacts**: Minimal impacts to foraging and feeding outside of breeding season, when tricolored blackbirds feed on insects more toed to agriculture. Minor impact during nesting season, as *Arundo* stands would offer low insect abundance, particularly larger insects.

Movement:

Tricolored blackbirds generally arrive on breeding grounds in early March through early April in the Central Valley. In Southern California, colonies establish April through May. In the winter they withdraw from coastal regions of Santa Barbara and San Diego Counties and portions of Northern California outside of the Central Valley. Wintering populations concentrate in the Sacramento-San Joaquin Delta and the central coast, particularly coastal areas of Monterey, Marin, Sonoma and Santa Cruz counties. Wintering tricolors are associated with open rangeland in the Sacramento-San Joaquin Delta and along the central California Coast. Dairies are attractive. In November large foraging flocks frequent the Sacramento-San Joaquin Delta region.

The migration to the rice districts follows flooding of rice ground. At this time, before nesting begins, roosting is in cattail marshes. They have no specific routes but demonstrate a specific movement schedule and pattern of areas colonized according to the California ephemeral spring climate, food and water availability. They show annual site fidelity, somewhat the result of adequate site availability or protected habitat resource.

***Arundo* impacts:** *Arundo* does not significantly impact movement but may impede access along marsh edges.

Decline and Threats:

Tricolored blackbirds have declined by more than 50% since 1970. Population declines are due, in part, to loss of wetlands due to agricultural and urban conversion as well as to draining and diverting water from wetlands. Historically tricolored blackbirds nested in wetlands with cattails, bulrushes, and willows, but as wetlands were converted to agricultural fields, towns, and business parks they have started nesting in agricultural fields. Now a large percentage of the population nests in triticale fields, a wheat x rye hybrid used to feed dairy cows. Where wetlands are available Tricolored Blackbirds continue to use them for nesting and foraging. More recently, tricolored blackbirds have also been found nesting in patches of Himalayan blackberry near stock ponds or irrigated pastures in the foothills of the Sierra Nevada, California.

Incidental enhancement of native predators (ravens, night herons, coyotes) through habitat alteration has likely increased predation rates on tricolored blackbirds. The role of exotic grass, native grass, several Mediterranean weeds and livestock grazing has not been closely studied, but may also affect both foraging and nesting. Tricolors are particularly attracted to ephemeral pools when foraging. Loss of these pools subtracts from highly suitable tricolor foraging habitat may have reduced food availability.

Status/Distribution or Historic and Current Range:

Tricolored blackbird colonies can still be found in wetland habitat at elevations less than 1000 m in the Central Valley. They also occur in other parts of the state, but the Central Valley is the core population center for the species.

***Arundo* overlap scores:** The tricolored blackbird is widely distributed in the Central Valley overlapping with *Arundo* on 22 of the 25 watershed units (Table 6-5). This sensitive species had the second widest distribution in the study. Overlap scores between *Arundo* and tricolored black birds were typically low to moderate (1 to 4), but the Colusa Trough-Stone Corral-Freshwater Creek unit scored high interaction (8).

Sources:

Beedy, E.C. 2008. California Bird Species of Special Concern: Tricolored Blackbird (Agelaius tricolor) Studies of Western Birds 1:437–443.

Beedy, E. C., W. J. Hamilton, III, R. J. Meese, D. A. Airola, and P. Pyle (2018). Tricolored Blackbird (Agelaius tricolor), version 3.1. In The Birds of North America (P. G. Rodewald, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bna.tribla.03.1.

Canavan, K., I. Paterson, M.P. Hill. 2014. The herbivorous arthropods associated with the invasive alien plant *Arundo* donax, and the native analog, *Phragmites australis*, in the Free State Province, South Africa.

Belenky, L., M. Bond. 2015. A Petition to List the Tricolored Blackbird (*Agelaius tricolor*) as Endangered under the California Endangered Species Act and Request for Emergency Action to

Protect the Species. Center for Biological Diversity Petition to the State of California, 19 August, 2015. 87 pp.

Hamilton, W. J. 2004. Tricolored Blackbird (*Agelaius tricolor*). *In* The Riparian Bird Conservation Plan: a strategy for reversing the decline of riparian-associated birds in California. California Partners in Flight. http://www.prbo.org/calpif/htmldocs/riparian_v-2.html.

Herrera, A.M., and T. Dudley. 2003. Reduction of riparian arthropod abundance and diversity as a consequence of giant reed (*Arundo donax*) invasion. Biological Invasions 5: 167-177.

The Tricolored Blackbird Working Group. 2007. Conservation Plan for the Tricolored Blackbird (*Agelaius tricolor*). Susan Kester (ed.). Sustainable Conservation. San Francisco, CA. Written for the USFWS. 55 pp.

Western Yellow-Billed Cuckoo (*Coccyzus americanus*)

Federal status: Threatened

State status: Endangered

Arundo impact score: 7/10 (High impact)

Alteration of abiotic structure and biological function (impacts on general ecological needs, reproduction, diet, or movement).

General Ecological Needs/Habitat Affinities:

Western yellow-billed cuckoos typically inhabit densely foliated, stands of deciduous trees and shrubs, particularly willows, with a dense understory formed by blackberry, nettles, and/or wild grapes, adjacent to slow-moving watercourses, backwaters, or seeps. River bottoms and other mesic habitats, including valley-foothill and desert riparian habitats, are necessary for breeding. Dense low-level or understory foliage with high humidity is preferred. Field studies and habitat suitability modeling have concluded that vegetation type (*e.g.*, willow scrub and cottonwood-willow forest), patch size, patch width, and distance to water are important factors determining the suitability of habitat for yellow-billed cuckoo breeding. Patch size is an important variable determining presence of cuckoos in California, with a trend toward increasing occupancy with increased patch size. Few cuckoos have been found in forested habitat of less than 25 acres. Willow-cottonwood habitat patches greater than 1,970 ft (600 m) in width were found to be optimal, and typically anything less than 328 ft (100 m) is unsuitable.

***Arundo* impacts:** *Arundo* and cuckoos both prefer broad river bottoms creating a significant interaction between the species. Cuckoos prefer well-developed riparian habitat that is dense with large gallery trees. *Arundo* displaces native vegetation and fires generate create younger serial stages that cuckoos do not prefer or utilize as habitat.

Breeding/Life History:

Western cuckoos breed in large blocks of riparian habitats, particularly woodlands with cottonwoods (*Populus fremontii*) and willows (*Salix* spp.). Dense understory foliage appears to be an important factor in nest site selection, while cottonwood trees are an important foraging habitat in areas where the species has been studied in California. Clutch size is usually two or three eggs, and chicks develop very rapidly, with a breeding cycle of 17 days from egg-laying to fledging of young. Although yellow-billed cuckoos usually raise their own young, they are facultative brood parasites, occasionally laying eggs in the nests of other yellow-billed cuckoos or of other bird species. Males and females reach sexual maturity the first year after hatching. Chicks are able to fly between 17 and 21 days after hatching and within a few weeks. Yellow-billed cuckoos are migratory and overwinter in South America.

***Arundo* impacts:** *Arundo* significantly degrades habitat directly by impacting existing vegetation through competition and indirectly by facilitating fire that displaces both dense native understory vegetation and canopy trees. It can fragment habitat by forming monotypic stands that isolate higher quality vegetation patches and by facilitating fire (through fuel accumulation) that eliminates local vegetation.

Diet:

More than 75 % of the yellow-billed cuckoo's diet is comprised of grasshoppers and caterpillars, though the species has been known to eat other insects such as beetles, cicadas, wasps, flies, katydids, dragonflies, and praying mantids.

***Arundo* impacts:** *Arundo* provides none of the preferred food sources and displaces native vegetation- particularly native willows and cottonwoods that are habitat for mourning cloak butterfly and caterpillars.

Movement:

Cuckoos leave North America in August and head to their wintering grounds in northwestern Costa Rica, Panama, and west of the Andes in Columbia, Ecuador, and Peru. It is believed that western cuckoos migrate primarily to southern Central America, remaining along the Pacific, and down into northwestern South America, remaining west of the Andes.

***Arundo* impacts:** No impact to migration. Movement within habitat is impacted by *Arundo* stands.

Decline and Threats:

Adequate patch size and loss of habitat are primary threats to western yellow-billed cuckoo populations, though other factors also appear to be limiting cuckoos. Increases in habitat have not stopped cuckoo decline. Principal causes of riparian habitat losses are conversion to agricultural and other uses, dams and river flow management, stream channelization and stabilization, and livestock grazing. Available breeding habitats for cuckoos have also been substantially reduced in area and quality by groundwater pumping and the replacement of native riparian habitats by invasive non-

native plants. Fragmentation effects include the loss of patches large enough to sustain local populations, leading to local extinctions, and the potential loss of migratory corridors, affecting the ability to recolonize habitat patches. Much of the catastrophic decline of the cuckoo in California has been directly attributed to breeding habitat loss from clearing and removal of huge areas of riparian forest for agriculture, urban development and flood control (see Chapter 5 - historic trends of geomorphology, particularly the loss of terraces, where mature gallery forest would occur). Another likely factor in the loss and modification of the yellow-billed cuckoo is the invasion by exotic tamarisk (*Tamarix* spp.) and *Arundo*. The spread and persistence of tamarisk and *Arundo* has resulted in significant changes in riparian plant communities. In monotypic tamarisk and *Arundo* stands, the most striking change is the loss of community structure. The multi-layered community of herbaceous understory, small shrubs, middle-layer willows, and over-story deciduous trees is often replaced by one monotonous layer. Plant species diversity has declined in many areas and relative species abundance has shifted in others. Other effects include changes in percent cover, total biomass, fire cycles, thermal regimes, and perhaps insect fauna. Conversion to tamarisk or *Arundo* typically coincides with reduction or complete loss of bird species strongly associated with cottonwood-willow habitat including the yellow-billed cuckoo.

Status/Distribution or Historic and Current Range:

Yellow-billed cuckoos occur in the western United States as a distinct population segment (DPS). The area for this DPS is west of the crest of the Rocky Mountains. In California prior to the 1930s, the species was widely distributed in suitable river bottom habitats, and was locally common. It is estimated that in California the species' range is now about 30% of its historical extent. Studies since the 1970s indicate that there are fewer than 50 breeding pairs in all of California. CNDDB data (1980-2014) document occurrences from multiple sections of the Sacramento River, Feather River and Kern River.

***Arundo* overlap scores:** The Western yellow-billed cuckoo in California is found in riparian habitat areas less than 1000 m and is narrowly distributed in the Central Valley overlapping with *Arundo* on 5 of the 25 watershed units (Table 7-4). Overlap scores between *Arundo* and Western yellow-billed cuckoo were typically moderate (4 to 6).

Sources:

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California Black Rail (*Laterallus jamaicensis coturniculus*)

Federal status: None

State status: Threatened

Arundo impact score: 3/10 (Low impact)

Slight or potential alteration of biological function (impacts on general ecological needs, reproduction, diet, or movement).

General Ecological Needs/Habitat Affinities:

Suitable California black rail habitat generally includes salt marshes, freshwater marshes, and wet meadows. Although Central Valley populations are also associated with mixed riparian habitat. Most California populations, especially in the southern part of the state, are non-migratory, and so these habitat types serve for breeding, foraging, and overwintering. In tidal areas, the rails also require dense cover of upland vegetation to provide protection from predators when rails must leave marsh habitats during high tides. Typical associated vegetation includes pickleweed (*Salicornia virginica*) in salt marshes and bulrush (*Scirpus* spp.) and cattails (*Typha spp*) in less saline habitats.

In the San Francisco Bay estuary California, black rail is confined to high tidal marsh (mostly above mean tide level) with a dense cover (>90%) of native halophytes and moist substrate. In San Pablo Bay marshes, CBRs occur in mature, dense stands of perennial pickleweed (*Sarcocornia pacifica*) often in association with alkali bulrush (*Bolboschoenus maritimus*) and alkali heath (*Frankenia salina*). East of the Carquinez Strait, the vertical range and relative abundance of pickleweed decreases from west to east and is supplanted by bulrushes (*Bolboschoenus* and *Schoenoplectus*) and cattails (*Typha*). California black rails are found in these complex associations in Suisun Bay and the lower Delta. Further inland in the Sacramento and San Joaquin Delta, they are also found in association with woody riparian shrub and tree species *Cornus sericea*, *Salix lasiolepis*, and *S. exigua*. Peripheral (fringing) vegetation adjacent to the marsh plain at or above mean higher high water provides important refuge habitat during periods of higher inundation California black rail presence was

positively associated with shorter distances to high-tide refugia in an analysis of California black rail-habitat relationships.

***Arundo* impacts:** *Arundo* may occur on margins of freshwater marsh and estuarine marsh, with minor impacts to movement and displacement of marsh vegetation. Impacts have the potential to be greater where rails are utilizing vegetation that is more riparian in character.

Breeding/Life History:

California black rails can breed from February through July. Multiple broods may be raised. Along the Lower Colorado River nests were in clumps of vegetation elevated an average of 6.4 centimeters (2.5 inches) above the mud substrate. Birds are generally secretive but aggressively defended the nests by scolding, raising their wings, and running toward any disturbance.

***Arundo* impacts:** Minor to no impacts.

Diet:

They prey on small (< 1 cm) invertebrates, chiefly insects, gleaned from marsh vegetation and mudflats; they also eat small seeds. Bulrush and cattail seeds appear to be an important component of their diet during the winter months when insect prey availability is low.

***Arundo* impacts:** Minor impacts. *Arundo* on adjacent habitat, particularly levees and berms can overhang marsh habitat, degrading it. *Arundo* biomass can also be deposited in marsh habitat impacting both marsh vegetation and open substrate

Movement:

California black rails forage in the same habitats that they use for breeding. Movement of rails within habitat is primarily by running along the ground, often using trails made by voles. Rails can also swim short distances. Flight, which exposes them to aerial predators, is uncommon. California black rails are non-migratory, but their occurrence at many locations indicates that dispersal movements do occur, however, there is no documentation about the timing or manner of such movements.

Black rails are a sedentary species, establishing and occupying relatively small territories. A radio-telemetry study of birds (n=48) in the Petaluma River found a mean fixed-kernel home range of 0.59 ha, a mean core area of 0.14 ha, and reported average daily movement of 27.6 (±1.8) meters and 38.4 (±5.5) meters during extreme high tides. Males have significantly larger home ranges and core areas than females

***Arundo* impacts:** *Arundo* stands along marsh edges may impede movement and avoidance of predators.

Decline and Threats:

Conservation concern for the California Black rail is high because of the linearity and low slope of the preferred habitat, its vulnerability to modification, and its historical loss of preferred habitat.

Much of the remaining tidal marsh habitat around the San Francisco Bay estuary is hardened at the landward edge (e.g., fill, roads, levees, berms, riprap) constraining the marsh plain to a narrow band between upland and bayshore. California black rails and other marsh species are expected to be negatively impacted by both sea-level rise and changes in the intensity and frequency of storms over the near and long-term. Other stressors on the California black rail include: invasive plants, predation, human intrusion into salt marshes, fragmentation of tidal habitat, stochastic events (floods, storms), potentially pesticides and other contaminants, and grazing and other land use on upland edge of the marsh. Invasive plants are altering the community structure of tidal marshes in San Francisco Bay. Two species in particular—*Spartina xalterniflora* and *Lepidium latifolium*—are of ecological concern because of their ability to alter the vegetative community, to change edaphic conditions, and to displace native plants and animals. *Lepidium* has invaded high marsh zones (especially in Suisun Bay) and non-native *Spartina* has invaded the lower mash elevations (especially in the central and south bays). Other invasive marsh plants are also of concern, e.g., *Atriplex prostrata, Apium graveolens, Juncus gerardii,* and *Polyypogon monspeliensis.* Predation is always a stressor, exacerbated in marshes with reduced vegetative cover, especially along the upland edge. Non-native predators feral cats, rats and perhaps red fox add to the predation pressure posed by native animals such as skunks, raccoons, northern harriers and birds of prey. Intrusion into marshlands by humans, including researchers, has the potential to alter habitat (create trails) and cause mortality of adults and chicks or to disturb nests. California black rails are hesitant to flush, and there have been instances of "take" due to trampling. Fragmentation of tidal habitat has been an historical stressor on California black rails and other marsh-dependent species. The restoration of tidal marshes throughout the San Francisco Bay estuary may be starting to arrest and even reverse this trend, however upland transition zone loss remains a concern. Stochastic events—earthquakes, floods, erosion associated with storm surges, and landslides—are ongoing potential stressors. Pesticides and other contaminants such as mercury have been found to have increased concentrations over historic levels in the eggs of San Francisco Bay estuary nesting birds in general. Although levels of contaminants in California black rail eggs are unknown, it likely mirrors that of other vertebrates that forage in marsh substrate. Grazing and other land-use practices on the upland edge of the marsh may reduce peripheral vegetative cover and reduce the quality and availability of high-tide refugia.

Arundo impacts: *Arundo* stands along marsh edges may offer cover and denning for predators, displace more favorable food and cover vegetation, and potentially contribute to erosion and fire.

Status/Distribution or Historic and Current Range:

The majority of California black rails (*Laterallus jamaicensis coturniculus*; >90 percent) are found in the tidal salt marshes of the northern San Francisco Bay region, primarily in San Pablo and Suisun Bays. Smaller populations occur in San Francisco Bay, the Outer Coast of Marin County, freshwater marshes in the foothills of the Sierra Nevada, and in the Colorado River Area. Inland populations appear to be isolated from coastal ones.

***Arundo* overlap scores:** California black rails are narrowly distributed in the Central Valley overlapping with *Arundo* on 6 of the 25 watershed units, most of which are in the Delta Region (Table 7-4). Overlap scores between *Arundo* and black rail were moderate (3 to 5).

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Bank Swallow (*Riparia riparia*)

Federal status: None

State status: Threatened

Arundo impact score: 7/10 (High impact)

Alteration of abiotic structure and biological function (impacts on general ecological needs, reproduction, diet, or movement).

General Ecological Needs/Habitat Affinities:

The bank swallow is largely found in riparian ecosystems, particularly rivers in the larger lowland valleys of northern California. Nesting colonies are located in vertical banks or bluffs in friable soils, and these colonies can support dozens to thousands of nesting birds. They can also live along ocean coasts or reservoirs. Their territories usually include vertical cliffs or banks where they nest in

colonies of 10 to 2,000 nests. Though in the past bank swallows were most commonly found around natural bluffs or eroding streamside banks, more and more often these swallows populate human-made sites, such as sand and gravel quarries or road cuts.

Banks or bluffs must be at least 1 m tall to have some predator deterrence values, and some source of continual erosion is almost always present. Breeding habitat vegetation is extremely varied because breeding sites are mostly selected for the suitability of the nesting bank. This variation occurs in almost all measures including vegetative cover, height, and species composition. There appears to be no selection for specific vegetation communities at most nest sites as selection is directed at the nesting bank or bluff itself where soil type, height, and slope are the primary factors determining whether the site will be used for nesting.

***Arundo* impacts:** *Arundo* can significantly impact geomorphic and hydrologic processes that regulate bank/bluff erosion. *Arundo* stands may have both positive and negative effects of bank erosion. Large *Arundo* stands reduce flow conveyance, increasing flooding and the number and duration of events where water is in contact with banks. *Arundo* stands may reduce direct contact of water against bluff faces when dense stands grow along banks, however these stands are poor bank protection, as *Arundo* is weekly rooted. *Arundo* stands move systems that would naturally have channel formations that are laterally unstable, to single stable channel forms, through over vegetation of the low flow channel. This reduces the frequency of channel migration within the riparian system, reducing the frequency of bank formation. These impacts are most significant on rivers and creeks that feed into the Sacramento River. The Sacramento River, being a large river with a naturally stable single deep channel, likely has less *Arundo* impacts on bank erosion processes and bank/bluff formation. Dense *Arundo* stands may reduce access to bluffs/banks by physically blocking use of faces that would support nesting.

Breeding/Life History:

Nesting colonies are located in vertical banks or bluffs in friable soils, and these colonies can support dozens to thousands of nesting birds. Nesting habitat is particularly prone to erosion, and habitat in some areas such as the Sacramento and Feather rivers is threatened with loss by flood control and bank protection projects.

The bank swallow is most affected by flooding and erosion disturbances. Flooding and associated erosion events can have positive and negative effects to this species. Flooding in freshwater environments causes erosion and soil deposition. Erosion creates the vertical banks needed for nesting, while the alluvial soils (e.g., clays, silts, and loams) deposited during flood events are the friable soils needed for the burrows. Lack of erosion results in banks and bluffs becoming more gently sloped and unsuitable for nesting. Flooding and erosion, however, can also result in the need for bank protection, channelization, and flood control projects thereby reducing the amount of nesting habitat. Wave wash from boats, high winds, and rapidly fluctuating water levels from reservoirs and storms can cause bank undercutting during the breeding season possibly causing mortality to eggs and young in Bank Swallow colonies.

***Arundo* impacts:** Significant impacts on erosion processes that forms banks/bluffs where nesting occurs, as outlined above. Dense *Arundo* stands may reduce access to bluffs/banks by physically blocking use of faces that would support nesting.

Diet:

Bank Swallows almost exclusively eat flying or jumping insects, such as bees, wasps, ants, butterflies or moths. The swallows catch insects while flying, usually at a height of 50 ft above water or open ground. Bank swallows only occasionally taking insects from the ground or from the surface of water.

***Arundo* impacts:** *Arundo* supports reduced insect diversity and abundance, particularly of flying insects. Few insects forage on *Arundo*.

Movement:

Bank Swallows arrive on their breeding grounds in California beginning in late March and early April, and the bulk of breeding birds arrive in late April and early May. Birds vacate their breeding grounds as soon as juveniles begin dispersing from the colonies around late June and early July. Breeding areas are essentially devoid of bank swallows by mid-July to early August. The fall migration period moves south through the state from early August to mid-September, with some stragglers recorded in southern California in early November. The bank swallow is essentially absent from the state during the winter period.

***Arundo* impacts:** Dense *Arundo* stands may reduce access to bluffs/banks by physically blocking use of faces that would support nesting.

Decline and Threats:

North American bank swallow numbers declined by over 5% per year from 1966 to 2014, resulting in a cumulative decline of 94%, according to the North American Breeding Bird Survey. Nesting habitat is particularly prone to erosion, and habitat in some areas such as the Sacramento and Feather rivers is threatened with loss by flood control and bank protection projects. Bank Swallows appear relatively insensitive to moderate levels of human-induced disturbance. In California, colonies occur on banks under actively farmed irrigated row crops and orchards. Several colonies occur in coastal locations at public seashores where human activity can be substantial. Loss and modification of wetlands, grasslands, and other open habitats used during migration and wintering has the potential to adversely affect bank swallows by reducing insect food resources and roosting habitat.

***Arundo* impacts:** *Arundo* modification of erosion/geomorphic processes and stands physically blocking access to bluff/bank faces.

Status/Distribution or Historic and Current Range:

The Bank Swallow nests in colonies in streamside banks across much of North America. It can also be found across most of Europe and Asia. The Bank Swallow occurs as a breeding species in

California in a hundred or so widely distributed nesting colonies in alluvial soils along rivers, streams, lakes, and ocean coasts.

The bank swallow is a locally common to uncommon breeding season resident in northern and central California. Few colonies, if any, exist in southern California where colonies historically occurred. Because nesting only occurs in suitable habitat, breeding areas are widely dispersed throughout northern and central California in major lowland valleys and coastal areas where alluvial soils exist. The major breeding population is confined to the Sacramento and Feather rivers and their major tributaries north of their confluence where an estimated 75% of California's breeding population was found in 1987. The Sacramento River population represented approximately 50% of the state's population in 1987, and the population occurs between Redding, Shasta County, and the Yolo Bypass, Yolo County. The Feather River supported 25% of the state's population in 1987; this population occurs between Oroville, Butte County, and the confluence of the Sacramento and Feather rivers, Sutter County.

***Arundo* overlap scores:** Bank swallows have a scattered distribution in the Central Valley overlapping with *Arundo* on 10 of the 25 watershed units, most of which are in the Sacramento Valley, but two of which are in the Delta region and one in San Joaquin Valley (Table 7-4). Overlap scores between *Arundo* and bank swallows were frequently high as *Arundo* is common in low land riparian forests where eroded creek and river banks are used as nesting locations for bank swallow colonies (7 to 9).

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Least Bell's Vireo (*Vireo bellii pusillus*)

Federal status: Endangered

State status: Endangered

Arundo impact score: 9/10 (Severe impact)

Significant alteration of abiotic structure and biological function and direct take of individuals.

General Ecological Needs/Habitat Affinities:

Least Bell's vireo is a small, olive-grey migratory songbird that nests and forages almost exclusively in riparian woodland habitats. Primary constituents of critical habitat for the vireo include riverine and floodplain habitat, and adjacent coastal sage scrub, chaparral, or other upland communities. Nesting habitat typically consists of well-developed overstories and understories, and low densities of aquatic and herbaceous cover. The understory frequently contains dense subshrub or shrub thickets. These thickets are often dominated by sandbar willow (*Salix exigua*), mulefat (*Baccharis salicifolia*), young individuals of other willow species, such as arroyo willow (*Salix lasiolepis*), red willow (*Salix laevigata*), and black willow (*Salix gooddingii*), and herbaceous species. Important overstory species include mature arroyo willow and black willows; occasional cottonwoods (*Populus* spp.) and western sycamores (*Platanus racemosa*) occur in some habitats. Additionally, coast live oak (*Quercus agrifolia*) can be a locally important overstory component, as can mesquite (*Prosopis* spp.).

***Arundo* impacts:** *Arundo* and vireos prefer the same dynamic high energy riparian habitat types, with a mix of established and early succession woody vegetation. Significant impacts from abiotic modification of the riverine system impact ecosystem to the detriment of the vireo. There changes include fire, geomorphic impacts that interfere with vegetation succession, and outright displacement of vegetation that vireos are dependent on. Direct take and long term degradation of habitat occurs after fires initiating in *Arundo* stands as well as wildland fires that are larger are more intense when *Arundo* is present.

Breeding/Life History:

Following pair formation, nest construction and egg laying takes approximately 5-7 days. Young typically fledge within 20-24 days after eggs are laid. The egg laying and incubation periods are critical to nesting success, and disturbance at this point may result in abandonment of the nest.

***Arundo* impacts:** *Arundo* displaces native vegetation reducing available habitat for nesting. *Arundo* does not have suitable structure for vireo nests.

Diet:

Least Bell's vireos are almost exclusively insectivorous, and forage in riparian woodland and suitable adjacent upland habitat.

***Arundo* impacts:** *Arundo* support a low abundance and diversity of insects, particularly in comparison to native vegetation (Herrera & Dudley 2003, Going & Dudley 2008). Vireos are rarely

seen feeding on *Arundo*, as the plants has few insects that directly feed on it. Birds are rarely seen feeding in *Arundo*.

Movement:

Least Bell's vireos generally begin to arrive from their wintering range in southern Baja California and establish breeding territories by mid- to late March. Most breeding vireos depart by the third week of September and only a very few individuals are found wintering in California. Most vireos occupy home ranges that are typically from 0.5-4.5 acres, but a few may be as large as 7.5 acres. Once the young are fledged they wander widely throughout the parents' territory.

***Arundo* impacts:** *Arundo* stands inhibit movement of avian species as the feed and spatially segregating the habitat. Territories frequently include *Arundo* stands but there is always a native component of the territory.

Decline and Threats:

Decline of vireos is primarily the result of habitat loss and degradation and cowbird nest-parasitism. The historic loss of wetlands (including riparian woodlands) has been estimated at 91%. Much of the potential remaining habitat is infested with non-native plants and cowbirds. Ongoing causes of destruction or degradation of habitat include: removal of riparian vegetation; invasion of non-native species (e.g. *Arundo*, cowbird); thinning of riparian growth, especially near ground level; removal or destruction of adjacent upland habitats used for foraging; increases in human-associated or human induced disturbances; and flood control activities, including dams, channelization, water impoundment or extraction, and water diversion. Vireos are also sensitive to many forms of human disturbance, including noise, night lighting, and consistent human presence in an area.

Status/Distribution or Historic and Current Range:

Historically the vireo was described as common to abundant in the appropriate riparian habitat from as far north as Tehama County, CA to northern Baja, Mexico. Habitat loss has fragmented most remaining populations into small, disjoint, widely dispersed subpopulations. Currently the largest population of vireos is on Marine Corps Base Camp Pendleton in San Diego County. Vireos occur as only scattered occurrences in the Central Valley, most of which are in San Juaquin.

***Arundo* overlap scores:** Vireos have a scattered distribution in the Central Valley overlapping with *Arundo* on 4 of the 25 watershed units, most of which are in the San Juaquin Valley (Table 7-4). Overlap scores between *Arundo* and vireos were low to moderate as *Arundo* was not abundant on streams where vireos have been observed and vireo observations are scattered and very uncommon (1 to 4).

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Western Snowy Plover (*Charadrius alexandrinus nivosus*)

Federal status: Threatened

State status: None (Species of special concern)

IUCN status: Near Threatened

Arundo impact score: 4/10 (Moderate impact)

Minor alteration of biological function (impacts on general ecological needs, reproduction, diet, or movement).

General Ecological Needs/Habitat Affinities:

The Pacific coast population of the western snowy plover breeds primarily above the high tide line on coastal beaches, sand spits, dune-backed beaches, sparsely-vegetated dunes, beaches at creek and river mouths, and salt pans at lagoons and estuaries. This habitat is unstable because of unconsolidated soils, high winds, storms, wave action, and colonization by plants. Less common nesting habitats include bluff-backed beaches, dredged material disposal sites, salt pond levees, dry salt ponds, and river bars. In winter, western snowy plovers are found on many of the beaches used for nesting as well as on beaches where they do not nest, in man-made salt ponds, and on estuarine sand and mud flats. Occurrences in the San Juaquin Valley are typically manmade percolation and evaporation ponds or remnant alkali playas.

***Arundo* impacts:** *Arundo* is not typically present or abundant in percolation and evaporation ponds, but it can occur, particularly if rhizome material is present in fill used to create berms.

Breeding/Life History:

The Pacific coast population of the western snowy plover breeds primarily on coastal beaches from southern Washington to southern Baja California, Mexico. Nesting western snowy plovers at coastal locations consist of both year-round residents and migrants. Migrants begin arriving at breeding

areas in central California as early as January, although the main arrival is from early March to late April. Since some individuals nest at multiple locations during the same year, birds may continue arriving through June. In California, pre-nesting bonds and courtship activities are observed as early as mid-February. Eggs are laid in scrapes (depression in the sand or other substrate created by the male). The earliest nests on the California coast occur during the first week of March in some years and by the third week of March in most years. Peak initiation of nesting is from mid-April to mid-June. Nests typically occur in flat, open areas with sandy or saline substrates; vegetation and driftwood are usually sparse or absent. In southern California, western snowy plovers nest in areas with 6 to 18 percent vegetative cover and 1 -14 % inorganic cover; vegetation height is usually less than six centimeters (2.3 inches).

Nests consist of a shallow scrape or depression, sometimes lined with beach debris (*e.g.*, small pebbles, shell fragments, plant debris, and mud chips); nest lining increases as incubation progresses. Driftwood, kelp, and dune plants provide cover for chicks that crouch near objects to hide from predators. Although driftwood is an important component of western snowy plover habitat, too much driftwood on a beach, which may occur after frequent and prolonged storm events, can be detrimental if there is not sufficient open habitat to induce the birds to nest. In southern California nests are usually located within 328 ft (100 m) of water, which could be either ocean, lagoon, or river mouth. Invertebrates are often found near debris, so driftwood and kelp are also important for harboring western snowy plover food sources. Hatching lasts from early April through mid-August, with chicks reaching fledging age approximately one month after hatching. Fledging of late-season broods may extend into the third week of September throughout the breeding range.

***Arundo* impacts:** *Arundo* biomass can degrade nesting habitat by covering open substrate. *Arundo* stands could provide cover and perching for predators.

Diet:

Western snowy plovers are primarily visual foragers, using the run-stop-peck method of feeding. They forage on invertebrates in the wet sand and amongst surf-cast kelp within the intertidal zone, in dry sand areas above the high tide, on salt pans, on spoil sites, and along the edges of salt marshes, salt ponds, and lagoons. They sometimes probe for prey in the sand and pick insects from low-growing plants. Western snowy plover food consists of immature and adult forms of aquatic and terrestrial invertebrates.

***Arundo* impacts:** *Arundo* debris and stands reduce habitat quality for food (invertebrates); impacts feeding as well as foraging for prey.

Movement:

While some western snowy plovers remain in their coastal breeding areas year-round, others migrate south or north for winter. In Monterey Bay, California, 41 % of nesting males and 24 % of the females were consistent year-round residents. At Marine Corps Base Camp Pendleton in San

Diego County, California, about 30 % of nesting birds stayed during winter. The migrants vacate California coastal nesting areas primarily from late June to late October. Plovers in the Central Valley and great Salt Lakes typically migrate to California and Mexican coasts in the winter.

***Arundo* impacts:** *Arundo* debris piles limit movement of young.

Decline and Threats:

Habitat degradation caused by human disturbance, urban development, introduced beachgrass (*Ammophila* spp.), and expanding predator populations have resulted in a decline in active nesting areas and in the size of the breeding and wintering populations.

***Arundo* impacts:** *Arundo* stands are correlated with predation as predators use stands for perching in nesting areas.

Status/Distribution or Historic and Current Range:

The Pacific coast population is defined as those individuals that nest within 50 miles of the Pacific Ocean on the mainland coast, peninsulas, offshore islands, bays, estuaries, or rivers of the United States and Baja California, Mexico. By the late 1970s, nesting western snowy plovers were absent from 33 of 53 locations with breeding records prior to 1970. By 2000 populations had declined further to 71 % of the 1977-1980 levels along the California coast and 27 % of the 1977-1980 levels in San Francisco Bay. However, since then populations have grown substantially, roughly doubling along the coast while fluctuating irregularly in San Francisco Bay. Recent population increases along the coast have been associated with implementation of management actions for the benefit of western snowy plovers and California least terns, including predator management and protection and restoration of habitat. Observations in the San Juaquin Valley demonstrate use of percolation and evaporation ponds, and occasionally other wetland features, but numbers of sites is low at 5-10 and overall number of individuals is modest (200-400).

***Arundo* overlap scores:** Plovers occur at only a few known sites in the southern San Juaquin Valley overlapping with *Arundo* on 3 of the 25 watershed units (Table 7-4). Overlap scores between *Arundo* and plovers were very low as *Arundo* was not abundant on stream systems where plovers have been observed and plover observations are scattered and uncommon (1 to 2).

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concern in California. Studies of Western Birds 1. Western Field Ornithologists, Camarillo, California, and California Department of Fish and Game, Sacramento. Snowy Plover (interior population)

Delta smelt (*Hypomesus transpacificus*)

Federal status: Threatened

State status: Endangered

IUCN status: Critically endangered

Arundo impact score: 1/10 (Very low/improbable impact)

Difficult to discern any interaction with *Arundo.*

General Ecological Needs/Habitat Affinities:

Delta smelt are found **only** in the Sacramento-San Joaquin Estuary. They have been found as far upstream as the mouth of the American River on the Sacramento River and Mossdale on the San Joaquin River. They extend downstream as far as San Pablo Bay. Delta smelt are found in brackish water. They inhabit open waters of bays, tidal rivers, channels, and sloughs; they rarely occur in water with salinity of more than 10-12 ppt; when not spawning, they tend to concentrate where salt water and freshwater mix (salinity about 2 ppt) and zooplankton populations are dense. Populations are concentrated mainly in the lower Delta and upper Suisun Bay after breeding (at least formerly). Adequate freshwater flows are needed to transport young to rearing habitat and to maintain rearing habitat in a favorable location (i.e., Suisun Bay).

***Arundo* impacts:** *Arundo* does not significantly interact with aquatic areas that support smelt. A very minor impact from *Arundo* water use could exist. *Arundo* does occur on banks of smelt habitat, but it is not clear what effect this would have on smelt.

Breeding/Life History:

During the late winter to early summer, delta smelt migrate to freshwater to spawn. Females only produce between 1000 and 2600 eggs which sink to the bottom and attach to the substrate. Larvae hatch between 10-14 days, are planktonic (float with the water currents), and are washed downstream until they reach areas near the entrapment zone where salt and fresh water mix. Delta smelt are fast growing and short-lived with the majority of growth within the first 7 to 9 months of life. Most smelt die after spawning in the early spring although a few survive to a second year.

***Arundo* impacts:** *Arundo* debris could have very minor effects on freshwater substrate structure, which could affect reproduction.

Diet:

Delta smelt feed entirely on small crustaceans called zooplankton.

***Arundo* impacts:** *Arundo* debris could have very minor effects on freshwater substrate structure, which could affect the life cycle and feeding of zooplankton.

Movement:

During the late winter to early summer, delta smelt migrate to freshwater to spawn. Most smelt die after spawning in the early spring although a few survive to a second year.

***Arundo* impacts:** No affect.

Decline and Threats:

The threats to the population are multiple and synergistic. In decreasing order of importance, they include: reductions in outflow from the Estuary, entrainment to water diversions, extremely high outflow, changes in food organisms, toxic substances, disease, competition, predation, and loss of genetic integrity by hybridization with the introduced wakasagi. The primary conservation need is recovery of natural processes in the Sacramento-San Francisco estuary, including outflow.

***Arundo* impacts:** Very minor impacts to water availability. Potential minor impacts to food and substrate for reproduction.

Status/Distribution or Historic and Current Range:

Larvae have been recorded from the Sacramento River as far north as its confluence with the Feather River. The delta smelt historically was one of the most common fish in the Sacramento-San Joaquin Estuary. Delta smelt abundance fluctuates greatly from year to year, however, there has been a dramatic decline of the delta smelt population and low population levels from 1983 to 1992. In 1993 abundance increased in an apparent response to an increase in available habitat brought about by a wet winter and spring. The total number of delta smelt is not known, however, delta smelt are considered environmentally sensitive because they have a one year life cycle, unusually low fecundity for a fish with planktonic larvae, a limited diet, and reside primarily within the interface between salt and freshwater.

***Arundo* overlap scores:** Smelt occur only in the Delta Region, overlapping with *Arundo* on 4 of the 25 watershed units (Table 7-4). Overlap scores between *Arundo* and smelt were low to moderate as *Arundo* does occur and can be fairly abundant in areas where smelt occur and smelt have a documented distribution throughout the delta, although numbers are low and declining (2 to 6).

Sources:

http://www.revivethesanjoaquin.org/content/delta-smelt-hypomesus-transpacificus

http://www.iucnredlist.org/details/10722/0

Steelhead Central Valley DPS (*Oncorhynchus mykiss irideus*)

Federal status: Threatened

State status: None

Arundo impact score: 5/10 (Low/moderate impact)

Minor alteration of abiotic structure and/or moderate alteration of biological function (impacts on general ecological needs, reproduction, diet, or movement).

General Ecological Needs/Habitat Affinities:

California Central Valley (CCV) Steelhead Distinct Population Segment (DPS) historically occurred throughout the Central Valley in river tributaries connected to the ocean. They can survive a wide range of temperature conditions, but require streams with adequate dissolved oxygen. Streambed modifications, dams, and vegetation change in riparian areas have impacted both their migration and spawning grounds severely. Steelhead are anadromous: adults migrate from the ocean to freshwater spawning grounds in the Sacramento and San Joaquin River drainages. Spawning habitat consists of gravel substrates free of excessive silt. Adults do not feed during their upstream journey, rather use their energy reserves. Once they are large enough, smolts migrate downstream to the ocean, and in order to successfully complete this journey they require refuge areas with good cover and water quality.

Riparian vegetation provides cover and protection from predators and areas of refuge from high velocities. Riparian vegetation is also important in maintaining low stream temperature, stabilizing banks, and providing food sources for young steelhead migrating downstream. To provide these benefits, riparian vegetation needs high vigor, density, and species diversity, including a mixture of canopy trees, brush and grasses. Areas of lowered velocity or reverse flow areas within the channel allow steelhead to use energy reserves efficiently during migration in order to save energy for spawning. Sediment removal of sandbars reduces flow-field complexity, particularly of edgewater eddies and low velocity zones. This likely results in adult steelhead migrating through higher velocities and consuming higher levels of reserved energy. If too much reserved energy is consumed and sufficient resting pools are not available, adults could be unable to reach spawning grounds, or have less energy for reproductive development. Furthermore, modification of sandbars and velocities could also simply increase the amount of time it takes for steelhead to reach spawning grounds. Removing and/or altering sandbars also reduces the convergence of flows through pools, thus reducing the processes that maintain pools. Pools provide cover and refuge. During the upstream migration steelhead rest in pools and during downstream migration smolts take refuge in pools during the day. Adults and smolts both require adequate flows for migration: they need enough water flow to travel up and down the river/stream, and to keep the river mouth open to the ocean.

Steelhead metabolism can be impacted by high water temperatures and the associated reduction in dissolved oxygen. Temperatures above 20° C have been known to stop fish migration, and

temperatures above 25° C can be lethal to salmon and trout. High levels of suspended sediment (e.g. 3,000-4,000 mg/L), generally the result of large storm events or channel grading activities, can significantly impact fish migration and survival. Fish can suffer from gill abrasion and reduced visibility, and suffer mortality after exposure of two or more days. Fish at the mouth of a river would be delayed 1-2 days until the initial flush of sediment passes after a storm.

***Arundo* impacts:** *Arundo* has a number of impacts on river systems- some of which are negative and others that may be positive. *Arundo* occurs in areas that steelhead pass through so impacts to migration are important to explore. *Arundo* is not good at stabilizing eroding banks stands and clumps break off and are undercut by flows. This may increase erosion rates locally. *Arundo* can form dense stands of vegetation on floodplains. These dense stands create conditions that deepen low flow channels and push systems to single thread form in comparison to more complex braided systems or broader shallow systems. This single deep channel may aid migration of steelhead. However, single thread narrow channels have higher velocity and fewer areas to rest; this could be a detriment. Single thread channels also tend to transport (carry) greater suspended loads under a larger range of flow events. This could also be a detriment to steelhead, particularly if there a large number of sediment inputs (such as agricultural inputs or other disturbed sites). Highly invaded systems may have *Arundo* water use that reduces duration of surface flows- this would potentially impact steelhead rearing and migration. *Arundo* biomass could be a stressor as both a physical hindrance to passage and as a contamination in the water column. Water temperature impacts for portions of the habitat where fish passage, spawning and rearing are occurring are extremely difficult to quantify. Large high order rivers, used for migration, have low density of *Arundo* and shading from vegetation is less relevant given the large channel size and water volume. Smaller order streams, where spawning and rearing occur, are more likely to see negative effects of less shading and higher water temperature, as *Arundo* is more abundant and closer to a narrower channel and provides less shade than mature tree cover.

Breeding/Life History:

Adult steelhead migrate from the ocean into freshwater streams to spawn between December and April. Female steelhead dig a nest in a stream area with suitable gravel composition, water depth, and velocity. Females may deposit eggs in four to five nests. Steelhead eggs hatch three to four weeks after being deposited. Juvenile steelhead typically spend one to two years rearing in freshwater before migrating to estuarine areas as smolts and then into the ocean to feed and mature. The majority of smolts enter the ocean at age two in March and April. They migrate at night and seek refuge and feed during the day. Steelhead can then remain at sea for up to three years before returning to fresh water to spawn.

***Arundo* impacts:** *Arundo* impacts on migration have been reviewed. Higher water temperatures, from less shading, could impact spawning and rearing sites. *Arundo* effects on erosion and sediment movement could degrade spawning sites.

Diet:

Young steelhead fry feed mostly on zooplankton. Adult steelhead eat aquatic and terrestrial insects, mollusks, crustaceans, fish eggs, minnows, and other small fishes.

***Arundo* impacts:** *Arundo* modification of abiotic process (bed forms and duration of flows) could negatively affect aquatic food resources. Higher water temperatures, from less shading, could also impact food resources. Steelhead diet also includes terrestrial arthropods, so *Arundo* stands may impact/reduce food resources because they support fewer arthropods than native vegetation.

Movement:

They are born in fresh water streams, where they spend their first 1-3 years of life. They then emigrate to the ocean where most of their growth occurs. After spending between one to four growing seasons in the ocean, steelhead return to their native fresh water stream to spawn. Unlike Pacific salmon, steelhead do not necessarily die after spawning and are able to spawn more than once.

***Arundo* impacts:** *Arundo* impacts to movement are difficult to interpret. *Arundo* pushes braided stream systems toward a more stable channel position, this could aid movement. *Arundo* debris in systems may be a hindrance to movement, although it is likely unusual that biomass would be submerged in the low flow channel, biomass usually drops out of the water column during peak flows on floodplains.

Decline and Threats:

Small populations of steelhead still occur in watersheds throughout most of the DPS range, but they are limited by dams and other barriers, degradation of existing habitat through land use practices, and other factors. The cumulative and synergistic effects of these threats make it difficult for CCV steelhead populations to contend with ongoing drought and fluctuating ocean conditions, and limit their ability to recover in the face of climate change. The anadromous life history form of steelhead is severely impacted by dams, development, urbanization, water diversions, timber harvest, agriculture, and other land use practices across the state.

***Arundo* impacts:** *Arundo* has an impacts on water use/availability, channel form, and sediment transport. These are complex hydro geomorphic processes explored in chapter 5. Most impacts would appear to be negative, others could facilitate migration.

Status/Distribution or Historic and Current Range:

California Central Valley (CCV) anadromous rainbow trout (Oncorhynchus mykiss), also known as steelhead, are federally listed as threatened under the federal Endangered Species Act. The CV steelhead Distinct Population Segment (DPS) includes all naturally spawned CV steelhead populations in the Sacramento and San Joaquin rivers and their tributaries, and also includes the Coleman National Fish Hatchery and the Feather River Fish Hatchery populations. Through this listing, the federal government requires estimates on population status and trends to assist in

recovery activities. Current CV steelhead monitoring is very limited, not standardized, and lacks dedicated funding. Abundance estimates for Central Valley steelhead are lacking due to the timing of winter spawning migrations during periods of high flows. Historically, it is likely that 50,000-100,000 adult steelhead returned per year based on estimates of available habitat and food resources. In 2016, NMFS estimated that an average of 4,600 adult steelhead returned to spawn per year, including to hatcheries. In contrast, resident trout both above and below dams are abundant.

***Arundo* overlap scores:** CCV steelhead occur throughout the Central Valley including all of Sacramento Valley units and reaches and most of San Juaquin, up to the Merced River, overlapping with *Arundo* on 18 of the 25 watershed units (Table 7-4). Overlap scores between *Arundo* and steelhead were varied greatly by watershed from low to high (1 to 7) as *Arundo* varied in abundance and steelhead have a documented distribution throughout most of the region.

Sources:

California Department of Fish and Wildlife, https://www.wildlife.ca.gov/Conservation/Fishes/Coastal-Rainbow-Trout-Steelhead

CalTrout, http://caltrout.org/wp-content/uploads/2017/05/CENTRAL-CALIFORNIA-COAST-STEELHEAD_final.pdf

NMFS. 2016. "2016 5-Year Review: Summary & Evaluation of Central California Coast Steelhead." 55pp. http://www.westcoast.fisheries.noaa.gov/publications/status_reviews/almon_steelhead/2016/2016_ccc-steelhead.pdf. Accessed 7/5/2016.

Programmatic Biological Opinion for the United States Army, San Francisco District Corps of Engineers' permit pursuant to 404 of the Clean Water Act for Monterey County Water Resources Agency regional General Permit for the Salinas River Channel Maintenance Program; National Marine Fisheries Service, Southwest Region, Long Beach CA. July 2003.

Reynolds, F.L, R.L. Reavis, J. Schuler. 1990. Central Valley salmon and steelhead restoration and enhancement plan. State of California Department of Fish and Game report. 113 pp.

Williams, J. G. 2006. Central Valley Salmon: A Perspective on Chinook and Steelhead in the Central Valley of California. San Francisco Estuary and Watershed Science 4. http://dx.doi.org/10.15447/sfews.2006v4iss3art2. Retrieved from https://escholarship.org/uc/item/21v9x1t7

Chinook salmon Central Valley spring-run ESU (*Oncorhynchus tshawytscha*)

Federal status: Threatened

State status: Threatened

Arundo impact score: 5/10 (Low/moderate impact)

Minor alteration of abiotic structure and/or moderate alteration of biological function (impacts on general ecological needs, reproduction, diet, or movement).

General Ecological Needs/Habitat Affinities:

The Chinook salmon Central Valley (CV) spring-run evolutionarily significant unit, or ESU, includes naturally spawned spring-run Chinook salmon originating from the Sacramento River and its tributaries, and also spring-run Chinook salmon from the Feather River Hatchery Spring-run Chinook Program. Chinook salmon use a variety of habitats during their lives, from ocean waters to small freshwater tributaries with pebble banks. In general, water temperature determines their presence in a particular stream segment in freshwater. Preferred holding habitat is characterized by maximum weekly average temperatures less than 21ºC, although there is some evidence that CVS Chinook in some areas may tolerate slightly higher temperatures, such as in Butte Creek, tributary to the Sacramento River. The upper limit of temperature tolerance for adult CVS Chinook appears to be between 21 and 24ºC. Eggs are less tolerant, and thus adults wait until stream temperatures drop to around13-15°C in the fall before spawning, while juveniles are more tolerant that eggs or juveniles. Embryos are the most sensitive life stage, and have a narrow range of temperature tolerance, with considerable mortality occurring at temperatures above 14-16°C.

Arundo impacts: *Arundo* has a number of impacts on river systems- some of which are negative and others that may be positive. *Arundo* occurs in areas that salmon pass through so impacts to migration are important to explore. *Arundo* is not good at stabilizing eroding banks, stands and clumps break off and are undercut by flows. This may increase erosion rates locally. *Arundo* can form dense stands of vegetation on floodplains. These dense stands create conditions that deepen low flow channels and push systems to single thread form in comparison to more complex braided systems or broader shallow systems. This single deep channel may aid migration of steelhead. However, single thread narrow channels have higher velocity and fewer areas to rest; this could be a detriment. Single thread channels also tend to transport (carry) greater suspended loads under a larger range of flow events. This could also be a detriment to salmon, particularly if there a large number of sediment inputs (such as agricultural inputs or other disturbed sites). Highly invaded systems may have *Arundo* water use that reduces duration of surface flows- this would potentially impact salmon rearing and migration. *Arundo* biomass could be a stressor as both a physical hindrance to passage and as a contamination in the water column. Water temperature impacts for portions of the habitat where fish passage, spawning and rearing are occurring are extremely difficult to quantify. Large high order rivers, used for migration, have low *Arundo* density and shading from vegetation is less relevant given the large channel size and water volume. Smaller

order streams, where spawning and rearing occur, are more likely to see negative effects of less shading and higher water temperature, as *Arundo* is more abundant and closer to a narrower channel and provides less shade than mature tree cover.

Breeding/Life History:

Adult CVS Chinook salmon migrate upstream during high runoff events starting in January or February. High flows, especially from snowmelt, allow adults to access higher elevation, smaller tributaries in April through June that are generally inaccessible to salmon at other times of the year. Adults seek out deep, cool pools in tributary streams less than 21°C (70°F) where these big fish hold over the summer before spawning in the fall. Female steelhead dig a nest in a stream area with suitable gravel composition, water depth, and velocity. Females may deposit eggs in four to five nests. Steelhead eggs hatch three to four weeks after being deposited. Juvenile spring-run Chinook spend varying amounts of time in freshwater before migrating to sea: 1) a matter of weeks after hatching, 2) a few months after hatching, or 3) an entire year or more in fresh water. Steelhead can then remain at sea for up to three years before returning to fresh water to spawn.

***Arundo* impacts:** *Arundo* impacts on migration have been reviewed. Higher water temperatures, from less shading, could impact spawning and rearing sites. *Arundo* effects on erosion and sediment movement could degrade spawning sites.

Diet:

Chinook salmon eat aquatic and terrestrial invertebrates, amphipods, and other crustaceans while young, and mainly fish as adults.

***Arundo* impacts:** *Arundo* modification of abiotic process (bed forms and duration of flows) could negatively affect aquatic food resources. Higher water temperatures, from less shading, could also impact food resources. Salmon diet also includes terrestrial arthropods, so *Arundo* stands may impact/reduce food resources because they support fewer arthropods than native vegetation.

Movement:

Spring-run Chinook salmon migrate upstream during high runoff events starting in January or February. High flows, especially from snowmelt, allow adults to access higher elevation, smaller tributaries in April through June that are generally inaccessible to salmon at other times of the year. Adults seek out deep, cool pools in tributary streams less than 21°C (70°F) where these big fish hold over the summer before spawning in the fall. They prefer pools with plenty of cover, such as rock ledges, bubble curtains, and woody debris. Most spring-run Chinook adults in the Central Valley are four years old and average 78.5cm (31 in.). Juvenile spring-run Chinook spend varying amounts of time in freshwater before migrating to sea: 1) a matter of weeks after hatching, 2) a few months after hatching, or 3) an entire year or more in fresh water.

***Arundo* impacts:** *Arundo* pushes low gradient low order braided stream systems toward a more stable channel position, this could aid movement. Higher gradient low order streams (valley

foothills) are less impacted by *Arundo*, as these streams tend to have a narrower profile and single channel form. *Arundo* debris in systems may be a hindrance to movement, although it is probably unusual that biomass would be submerged in the low flow channel, biomass usually drops out of the water column during peak flows on floodplains. *Arundo* debris in high order rivers would not restrict movement.

Decline and Threats:

Loss of historic spawning habitat for CVS Chinook salmon remains a major threat, as most of that habitat continues to be blocked by the direct or indirect effects of dams. Since CVS Chinook salmon were originally listed as threatened in 1999, spawning habitat for those fish has been expanded very little compared to the hundreds of miles of habitat blocked by dams. The remaining spawning and rearing habitat for this species is severely degraded. Threats to habitat include, but are not limited to: (1) operation of antiquated fish screens, fish ladders, diversion dams, and inadequate flows on streams throughout the Sacramento River Basin including on Deer, Mill, and Antelope creeks; (2) levee construction and maintenance projects that have greatly simplified riverine habitat and have disconnected rivers from the floodplain; and (3) water delivery and hydroelectric operation on Butte Creek, Battle Creek, the main-stem Sacramento River, and the Feather River.

***Arundo* impacts:** *Arundo* can have impacts on water use/availability, channel form, and sediment transport. These are complex hydro geomorphic processes explored in chapters 4 and 5. Most impacts would appear to be negative (decreasing water availability), but others could facilitate movement/migration (channel form).

Status/Distribution or Historic and Current Range:

19th century spring-run Chinook salmon were once as abundant as fall-run Chinook in the Central Valley, numbering approximately one million returning adults per year. Over the past forty years, annual abundance has varied from highs around 30,000 fish to lows of about 3,000 fish. Since 2012, population estimates have plummeted.

CVS Chinook salmon historically ranged throughout the Central Valley in both the Sacramento and San Joaquin watersheds. Today, some CVS Chinook are still found in Battle Creek and in the Sacramento River below Keswick Dam, but current distribution of viable populations is limited to just a handful of streams in the northern Sierra Nevada Region. This includes naturally reproducing populations in Mill, Deer, and Butte Creeks. CVS Chinook also occur on a regular basis in some of the smaller tributaries, such as Antelope, Big Chico, Little Chico, Beegum, and Clear creeks, but these populations are presumably not self-sustaining.

***Arundo* overlap scores:** Spring-run Chinook salmon occur throughout most of the Sacramento Valley and migrate through the Delta, overlapping with *Arundo* on 14 of the 25 watershed units (Table 7-4). Overlap scores between *Arundo* and salmon varied greatly by watershed from low to high (1 to 8) as *Arundo* varied in abundance significantly and salmon have a documented distribution throughout most of the Sacramento Valley and Delta.

Sources:

CALIFORNIA CENTRAL VALLEY RECOVERY DOMAIN5- Year Review: Summary and Evaluation of Central Valley Spring -run Chinook Salmon Evolutionarily Significant Unit NOAA's National Marine Fisheries Service West Coast Region, April 2016. http://www.westcoast.fisheries.noaa.gov/publications/status_reviews/salmon_steelhead/2016/2016_cv-spring-run-chinook.pdf

CalTrout, Summary of Spring Chinook Salmon, http://caltrout.org/wp-content/uploads/2017/05/CV-SPRING-CHINOOK-SALMON-final.pdf

Reynolds, F.L, R.L. Reavis, J. Schuler. 1990. Central Valley salmon and steelhead restoration and enhancement plan. State of California Department of Fish and Game report. 113 pp.

Williams, J. G. 2006. Central Valley Salmon: A Perspective on Chinook and Steelhead in the Central Valley of California. San Francisco Estuary and Watershed Science 4. http://dx.doi.org/10.15447/sfews.2006v4iss3art2. Retrieved from https://escholarship.org/uc/item/21v9x1t7

Chinook salmon Sacramento River winter-run ESU (*Oncorhynchus tshawytscha*)

Federal status: Endangered

State status: Endangered

Arundo impact score: 3/10 (Low impact)

Slight or potential alteration of biological function (impacts on general ecological needs, reproduction, diet, or movement).

General Ecological Needs/Habitat Affinities:

The Sacramento River winter-run ESU includes all naturally spawning populations of SR winter-run Chinook Salmon in the Sacramento River. Winter-run Chinook salmon are unique because they spawn during summer months when air temperatures usually approach their yearly maximum. As a result, winter-run Chinook salmon require stream reaches with cold water sources that will protect embryos and juveniles from the warm ambient conditions in summer.

***Arundo* impacts:** *Arundo* impacts vary significantly by river size on the different portions of the Sacramento River. Impacts are greater on the upper reaches of the Sacramento River where spawning habitat occurs, rearing and migration reaches in the middle portion of the watershed are less impacted and lowest reaches, which are used more for migration and juvenile development have less impacts. These impacts are described below.

Breeding/Life History:

Sacramento River Winter-run Chinook Salmon display a unique migration timing and spawn in the middle of the summer. Spawning occurs from mid-April to mid-August, peaking in June and July,

in the upper Sacramento River reach between Keswick Dam (Redding) and Red Bluff Diversion Dam (this area includes the headwaters watershed unit and the Upper Sacramento River reach for this study). Chinook salmon spawn in clean, loose gravel, in swift, relatively shallow riffles, or along the margins of deeper river reaches where suitable water temperatures, depths, and velocities favor redd construction and oxygenation of incubating eggs. Winter run Chinook salmon were adapted for spawning and rearing in the clear, spring-fed rivers of the upper Sacramento River Basin, where summer water temperatures were typically 50°F to 59°F. Chinook salmon require clean loose gravel from 0.75 to 4.0 inches in diameter for successful spawning.

Because the embryo incubation life stage begins with fertilized egg deposition and ends with fry emergence from the gravel, embryo incubation occurs from late April through mid-October. Fry emergence occurs from mid-June through mid-October (NMFS 1997). Within the appropriate water temperature range, eggs normally hatch in 40 to 60 days. Newly hatched fish (alevins) normally remain in the gravel for an additional four to six weeks until the yolk sac has been absorbed (NMFS 1997). Upon emergence from the gravel, fry swim or are displaced downstream (Healey 1991). Fry seek streamside habitats containing beneficial aspects such as riparian vegetation and associated substrates that provide aquatic and terrestrial invertebrates for food, predator avoidance cover, and slower water velocities for resting (NMFS 1996a). These shallow water habitats have been described as more productive juvenile salmon rearing habitat than the deeper main river channels. Once downstream movement has commenced, salmon fry continue this movement until reaching the estuary or they might reside in the stream for a time period that varies from weeks to a year. Emigration of juvenile Sacramento River winter-run Chinook salmon past RBDD may begin after almost one year in the river. They begin to move down river as early as mid- July, typically peaking numbers in September, and can continue through March in dry years. As Chinook salmon begin the smoltification stage, they are found rearing further downstream where ambient salinity reaches 1.5 to 2.5 parts per thousand. Juvenile Sacramento River winter-run Chinook salmon occur in the Delta primarily from November through early May. Emigration to the ocean begins as early as November and continues through May.

***Arundo* impacts:** Spawning areas can be impacted by *Arundo*. *Arundo* has the potential to change water temperature by providing less shade. But the upper river is still fairly large, with a broad central channel, in size so this effect is likely minor. Geomorphic modification could have an impact, but the upper Sacramento River is still large and would likely have a stable single channel, at least under its current modified structure. *Arundo* has the potential to modify erosion and bed characteristics, but this upper portion of the river has low density of *Arundo*, so the impact would be low. Impacts to juveniles below Red Bluff are likely minor and related to diet.

Diet:

Sacramento River winter run Chinook salmon eat aquatic and terrestrial invertebrates, amphipods, and other crustaceans while young, and mainly fish as adults.

***Arundo* impacts:** Impacts are tied to life stage diet. Young fry diet includes terrestrial insects which could be less abundant as *Arundo* has lower insect diversity and abundance. But this impact is likely minor given terrestrial inputs into the river system. Smolts and juveniles would likely have less *Arundo* impacts to diet, unless prey species (fish) were shown to have *Arundo* impacts to their reproduction and diet.

Movement:

Adult SR winter-run Chinook Salmon pass under the Golden Gate Bridge to begin their spawning migration in November and continue upstream from December through early August. SR winter-run Chinook Salmon spawn in the upper mainstem Sacramento River from mid-April through August, peaking in June and July. Since spawning occurs during the warmest time of the year, adult spawners require stream reaches with plentiful cold, clean water that will protect embryos and juveniles from the warm ambient summer conditions. SR winter-run Chinook Salmon require water temperatures between 42.5 and 57.5 degrees Fahrenheit. Suitable water temperatures for adult winter run Chinook salmon migrating upstream to spawning grounds range from 57°F to 67°F (NMFS 1997). However, winter-run Chinook salmon are immature when upstream migration begins, and need to hold in suitable habitat for several months prior to spawning. The maximum suitable water temperature reported for holding is 59°F to 60°F (NMFS 1997). Because water temperatures in the lower Sacramento River below the RBDD generally begin exceeding 60 degrees Fahrenheit (°F) in April, it is likely that little, if any, suitable holding habitat exists in the lower Sacramento River. It most likely is only used by adults as a migration corridor. Juvenile SR winter-run Chinook Salmon fry and smolts emigrate downstream from July through March through the Sacramento River, and reach the Delta from September through June.

***Arundo* impacts:** *Arundo* may have minor impacts to water temperature as stands provide less shade in comparison to tree cover. However, most of the Sacramento River reaches have wide and fairly deep channel configurations so shading would only be a factor in the upper most reach by Redding. *Arundo* biomass is also very unlikely to restrict movement as river reaches have channels that are too large for *Arundo* to block them. *Arundo* would drop out of the river on flood plains during high flow events.

Decline and Threats:

Sacramento River Winter-run Chinook Salmon display a unique migration timing and spawn in the middle of the summer. Prior to Shasta and Keswick Dams, adults spawned in the cold-water upper reaches of the McCloud, Pit and Sacramento Rivers. The summer-spawning life-history trait was advantageous to the species, since hatching occurred prior to fall-run Chinook Salmon spawning. Blockage to spawning grounds reduced SR winter-run Chinook Salmon to one population that spawn in the mainstem below Keswick Dam. Here, salmon egg-nests are vulnerable to high water temperatures, air exposure due to lack of flow, and other threats associated with Shasta Dam hydro-power and water supply delivery operations. If the temperature of the water that is released becomes too high there can be catastrophic losses in the spawning grounds. Levee and bank

protection measures restrict the meandering of the river, which would normally release gravel into the river through natural erosion and deposition processes.

Water management can be the largest human controlled factor for SR winter-run Chinook Salmon populations on the Sacramento River and in most years, it is maintained in favor of SR winter-run Chinook Salmon survival. In drought years or when lake water levels are low due to human demand, a lack of cold water can harm an entire year class of juvenile SR winter-run Chinook Salmon.

Key threats to the mainstem Sacramento River migratory corridor include: major ecological shifts in the Sacramento-San Joaquin Delta ecosystem, loss of riparian and instream habitat affecting juvenile rearing/growth and outmigration, loss of floodplain habitat affecting juvenile rearing/growth and outmigration, entertainment in agricultural diversions, disease (often exacerbated by high water temperatures), stranding due to Water Project operations and natural events, interspecies competition, human mediated high predation rates, degraded water quality from agricultural and urban runoff, and climate change.

***Arundo* impacts:** *Arundo* can have impacts on water use/availability, channel form, and sediment transport. These are complex hydro geomorphic processes explored in chapters 4 and 5. Most impacts would appear to be negative (decreasing water availability), but others could facilitate movement/migration (channel form). However, the size of the Sacramento River reduces the magnitude of these impacts for most reaches significantly.

Status/Distribution or Historic and Current Range:

Historically, SR winter-run Chinook Salmon spawned in the upper reaches of Sacramento River tributaries, including the McCloud, Pit, and Upper Sacramento Rivers where cold, spring sourced water is plentiful. Access to these cold-water tributaries has been blocked since the construction of Shasta Dam (1938-1945) and Keswick Dam (1941-1950). These dams limit the range of spawning habitat to the upper Sacramento River between Red Bluff and Keswick Dam (Redding). Rearing habitat occurs from Redding to the Delta. This listing only covers the Sacramento River.

***Arundo* overlap scores:** Sacramento River Winter-run Chinook salmon occur Redding to the Delta, overlapping with *Arundo* on 4 of the 25 watershed units that include the upper Sacramento River and three river reaches (Table 7-4). Overlap scores between *Arundo* and salmon varied watershed/reach from low to moderate (1 to 6) as *Arundo* varied in greatly abundance.

Sources:

https://www.wildlife.ca.gov/Conservation/Fishes/Chinook-Salmon/Winter-run

CALIFORNIA CENTRAL VALLEY RECOVERY DOMAIN5- Year Review: Summary and Evaluation of Central Valley Spring -run Chinook Salmon Evolutionarily Significant Unit NOAA's National Marine Fisheries Service West Coast Region, April 2016.

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National Marine Fisheries Service (NMFS). 2014. Recovery Plan for Evolutionarily Significant Units of Sacramento River Winter-run Chinook Salmon and Central Valley Spring-run Chinook Salmon and the Distinct population Segment of California Central Valley Steelhead. California Central Valley Area Office, July 2014.

Reynolds, F.L, R.L. Reavis, J. Schuler. 1990. Central Valley salmon and steelhead restoration and enhancement plan. State of California Department of Fish and Game report. 113 pp.

Stevens, D.E., L.W. Miller. 1983. Effects of river flow on abundance of young Chinook salmon, American shad, longfin smelt, and delta smelt in the Sacramento-San Joaquin river system. North American Journal of Fisheries Management 3:425-437.

Williams, J. G. 2006. Central Valley Salmon: A Perspective on Chinook and Steelhead in the Central Valley of California. San Francisco Estuary and Watershed Science 4. http://dx.doi.org/10.15447/sfews.2006v4iss3art2 Retrieved from https://escholarship.org/uc/item/21v9x1t7

Longfin smelt (*Spirinchus thaleichthys*)

Federal status: Candidate

State status: Threatened

Arundo impact score: 1/10 (Very Low/Improbable impact)

Difficult to discern any interaction with *Arundo.*

General Ecological Needs/Habitat Affinities:

The longfin smelt is an anadromous fish found in California's bay, estuary, and nearshore coastal environments from San Francisco Bay north to Lake Earl, near the Oregon border. The San Francisco Estuary and the Sacramento-San Joaquin Delta supports the largest longfin smelt population in California, and Humboldt Bay likely ranks second in longfin smelt abundance.

Habitat includes a wide range of temperature and salinity conditions in coastal waters near shore, bays, estuaries, and rivers; some populations are landlocked in lakes.

***Arundo* impacts:** Very minor impacts related to possible impacts from added organic biomass/litter in river systems and *Arundo* stands on edges of sloughs and brackish marsh areas.

Breeding/Life History:

Longfin smelt have a short lifespan. Most reach maturity in two years. They spend their adult life in bays, estuaries, and nearshore coastal areas and migrate into freshwater rivers to spawn. Spawning occurs in fresh water primarily from January through March, over sandy-gravel substrates, rocks, and aquatic plants. These freshwater rivers and streams are in the Delta. Afterwards most adults die. After hatching, larvae move up into surface waters and are transported downstream into brackish-water nursery areas.

***Arundo* impacts:** Possible impacts related to freshwater habitat used for spawning. *Arundo* biomass could cover spawning substrate, but impact likely minor.

Diet:

Longfin smelt eat opossum shrimp, copepods, and crustaceans.

***Arundo* impacts:** No impacts likely these food resources are in open water.

Movement:

Their spatial distribution within a bay or estuary is seasonally variable. Generally speaking longfin smelt are found closer to the ocean during summer whereas they move upstream in cool seasons. They can survive summer temperatures up to 20°C. Longfin smelt may also make daily migrations; remaining deep during the day and rising to the surface at night.

***Arundo* impacts:** No impacts likely to migration and movement between San Pablo Bay and large high order rivers and streams in the Delta.

Decline and Threats:

Declines are well documented in California, but there is a lack of trend information for most of the remainder of the range, where populations are generally considered common or abundant. Declines in the Sacramento-San Joaquin estuary in California are due mainly to the effects of water diversions from the Delta. Low flows result in upstream movement of the productive freshwater-saltwater mixing zone, constricting the size of favorable habitat and making the fishes vulnerable to diversion into water project pumps and structures. Low flows also fail to disperse larvae downstream into productive nursery areas in Suisun Bay.

Other potential threats include pesticide runoff from agricultural areas and invasions by exotic species such as clams and copepods. Due to a two-year life cycle, relatively brief periods of reproductive failure could lead to sharp declines.

***Arundo* impacts:** *Arundo* could be slightly impacting longfin smelt, but the impact would be very minor.

Status/Distribution or Historic and Current Range:

Range extends along the Pacific coast of North America from the Sacramento-San Joaquin estuary and Monterey Bay (single record), California, north to the southwestern Gulf of Alaska. In California

it occurs in the Eel River mouth (little suitable habitat, no recent records), Van Duzen River in Eel River drainage, Russian River estuary, San Francisco Bay-Sacramento-San Joaquin estuary, and the Gulf of the Farallones.

***Arundo* overlap scores:** Longfin smelt occur in the Delta and into the lower Sacramento River reach, overlapping with *Arundo* on 5 of the 25 watershed units (Table 7-4). Overlap scores between *Arundo* and longfin smelt varied watershed/reach from low to moderate (2 to 6) as *Arundo* varied in greatly abundance.

Sources:

Department of Fish and Widlife Longfin Smelt factsheet
https://www.dfg.ca.gov/delta/data/longfinsmelt/documents/LongfinsmeltFactSheet_July09.pdf

NatureServe. 2013. *Spirinchus thaleichthys*. The IUCN Red List of Threatened Species 2013: e.T184099A18233586. http://dx.doi.org/10.2305/IUCN.UK.2013-1.RLTS.T184099A18233586.en.

Stevens, D.E., L.W. Miller. 1983. Effects of river flow on abundance of young Chinook salmon, American shad, longfin smelt, and delta smelt in the Sacramento-San Joaquin river system. North American Journal of Fisheries Management 3:425-437.

Giant garter snake (*Thamnophis gigas*)

Federal status: Threatened

State status: Threatened

IUCN status: Vulnerable

Arundo impact score: 3/10 (Low impact)

Slight or potential alteration of biological function (impacts on general ecological needs, reproduction, diet, or movement).

General Ecological Needs/Habitat Affinities:

The habitat of this highly aquatic species includes primarily marshes and sloughs, sometimes low-gradient streams, ponds, and small lakes, with cattails, bulrushes, willows, or other emergent or water-edge vegetation usually present and used for basking and cover. Because of the direct loss of natural habitat, this snake now relies heavily on rice fields in the Sacramento Valley, but it also uses managed marsh areas in various national wildlife refuges and state wildlife areas. Essential habitat components consist of: (1) adequate water during the snake's active season (early spring through mid-fall) to provide adequate permanent water to maintain dense populations of food organisms; (2) emergent, herbaceous wetland vegetation, such as cattails and bulrushes, for escape cover and foraging habitat during the active season; (3) upland habitat with grassy banks and openings in waterside vegetation for basking; and (4) higher upland terrace habitat for cover and refuge from

flood waters during the snake's inactive season in the winter. The giant garter snake is absent from large rivers and other waters with populations of large, introduced, predatory fishes, and from wetlands with sand, gravel, or rock substrates. Riparian woodlands do not provide suitable habitat because of excessive shade and inadequate prey resources. The U.S. Fish & Wildlife Recovery Plan for giant garter snake includes recommendations for habitat enhancement through the removal of invasive plants.

***Arundo* impacts:** *Arundo* typically does not form dense stands in preferred habitat areas (marshes and sloughs) but does occur as scattered patches. Minor impacts along edges of habitat. Minor impacts can occur in late season and overwinter habitat, as these higher areas along levees and banks can have more *Arundo* cover.

Breeding/Life History:

Mating takes place soon after emergence in the Spring. Females bear live young from July through early September.

***Arundo* impacts:** Minor to no impact, *Arundo* is very scattered in breeding/rearing habitat (marshes and sloughs).

Diet:

Feed primarily on aquatic fish, frogs and tadpoles. Historical prey has been extirpated in much of this snake's range, leaving it to consume introduced fish and bullfrogs.

***Arundo* impacts:** Minor to no impact, *Arundo* is very scattered in feeding habitat (marshes and sloughs).

Movement:

Highly aquatic. Active during daylight, and at night in hot weather. Secretive and difficult to approach, this snake will quickly drop into the water from its basking site and dive to the bottom before the observer can get close. Emerges from overwintering sites in March. Basks on vegetation near water in spring, and utilizes animal burrows and vegetation piles during hotter weather. Some snakes active until October and then they overwinter in animal burrows.

***Arundo* impacts:** *Arundo* impacts are minor for most of the year, when marsh and aquatic habitat are occupied. Later in the season, *Arundo* stands and patches can have impacts along levees and higher terrace and floodplain riparian habitat. *Arundo* occupies this habitat space more abundantly, where it may block access, reduce quality of habitat, and can effect rodent populations, which make the burrows that are used for overwintering.

Decline and Threats:

Listed as Threatened because its area of occupancy is less than 2,000 km², its distribution is severely fragmented. Loss and fragmentation of wetland habitats have extirpated the Giant Garter Snake from the majority of its historical range. Loss and degradation of habitat remain the greatest threat

to the survival of the species. Threats include: habitat loss (e.g., through large-scale urbanization in the American Basin, dewatering of habitat through water diversions and impoundments), flooding (in rice production areas), contaminants (e.g., selenium and salinity in North and South Grassland areas), agricultural and vegetation maintenance activities (e.g., on levees and canal borders), vehicular traffic (on levees and roads along canals), livestock grazing, and introduced predators (e.g., house cats, bullfrogs, perhaps bass).

***Arundo* impacts:** *Arundo* does occur on levees and banks. These areas are actively managed to maintain the structures. Presence of *Arundo* can increase the frequency and intensity of maintenance.

Status/Distribution or Historic and Current Range:

Historically the range included much of the floor of the Central Valley (Sacramento and San Joaquin valleys) from Butte County in the north to Kern County in the south. The species apparently is now extirpated from most of the range in the San Joaquin Valley. Extant populations are distributed in portions of the rice production zones of Sacramento, Sutter, Butte, Colusa, and Glenn counties; along the western border of the Yolo Bypass in Yolo County; and along the eastern fringes of the Sacramento-San Joaquin Delta from the Laguna Creek-Elk Grove region of central Sacramento county southward to the Stockton area of San Joaquin County. As of 1992, there were 13 known populations as follows: (1) Butte Basin, (2) Colusa Basin, (3) Sutter Basin, (4) American Basin, (5) Yolo Basin-Willow Slough, (6) Yolo Basin-Liberty Farms, (7) Sacramento Basin, (8) Badger Creek-Willow Creek, (9) Caldoni Marsh, (10) East Stockton-Diverting Canal and Duck Creek, (11) North and South Grasslands (extirpated?), (12) Mendota (extirpated?), and (13) Burrell-Lanare (probably extirpated). These population largely coincide with historical riverine flood basins and tributary streams. Populations 1 to 4 are associated with rice production zones; populations 5 to 13 mainly are in small, isolated patches of valley floor habitat.

***Arundo* overlap scores:** Giant garter snake occur throughout the Central Valley, although they do not occur in the upper portions of either valley, overlapping with *Arundo* on 11 of the 25 watershed units (Table 7-4). Overlap scores between *Arundo* and giant garter snake varied by watershed unit from low to high (2 to 8), as many watershed units had fairly low interaction between populations.

Sources:

Halstead, B.J., G.D. Wylie, M.L. Casazza. 2010. Habitat suitability and conservation of the giant gartersnake (*Thamnophis gigas*) in the Sacramento Valley of California. *Copea* 4:591-599.

Hammerson, G.A. 2007. *Thamnophis gigas*. The IUCN Red List of Threatened Species 2007: e.T21706A9310655. http://dx.doi.org/10.2305/IUCN.UK.2007.RLTS.T21706A9310655.en. Downloaded on 11 April 2018.

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U.S. Fish & Wildlife Service. 2017. Recovery plan for the giant garter snake (*Thamnophis gigas*). US Fish & Wildlife Service, Region 8 publication. Sacramento, CA. 79 pp.

California red-legged frog (*Rana draytonii*)

Federal status: Threatened

State status: None

IUCN status: Critically endangered

Arundo impact score: 2/10 (Very Low impact)

Potential alteration of biological function (impacts on general ecological needs, reproduction, diet, or movement).

General Ecological Needs/Habitat Affinities:

This species usually occurs in or near quiet permanent water of streams, marshes, ponds, lakes, and other quiet bodies of water. It is most common in lowlands or foothills and is frequently found in woods adjacent to streams. Ephemeral wetland habitats require animal burrows or other moist refuges for estivation when the wetlands are dry.

In summer, frogs estivate in small mammal burrows, leaf litter, or other moist sites in or near (within a few hundred feet of) riparian areas. Individuals may range far from water along riparian corridors and in damp thickets and forests. Breeding occurs in permanent or seasonal water of ponds, marshes, or quiet stream pools, sometimes in lakes. Eggs often are attached to emergent vegetation and float at surface.

***Arundo* impacts:** *Arundo* prefers high energy stream and river systems that are low gradient and lower elevation. However, *Arundo* can occur along edges of ponds, lakes, and lower energy streams. *Arundo* is not typically found in foothill and mountain habitat, which is red legged frog suitable habitat.

Breeding/Life History:

Reproduction is aquatic and fertilization is external. The eggs hatch into tadpoles which feed in the water and eventually grow four legs, lose their tails and emerge onto land where they disperse into the surrounding territory. Males typically become reproductively mature at 2 years, females at 3 years of age. Mating and egg-laying occurs in permanent and temporary bodies of water mostly ponds, but also marshes, lagoons, and slow-moving parts of streams. Breeding occurs from late November to April, depending on the location, and lasts for only a week or two. Females lay from 300 4,000 eggs in a large gelatinous oval cluster which is attached to plants near the water surface. Eggs hatch after about four weeks. Tadpoles typically metamorphose in four to seven months, but at some sites they overwinter and metamorphose the following summer.

***Arundo* impacts:** *Arundo* does not overlap with most breeding habitat (ponds, slow moving foothill streams). RLF are not know to occur in marshes and lagoons in the lower valley floor or the Delta.

Diet:

Diet consists of a wide variety of invertebrates, and occasionally small vertebrates such as fish, mice, frogs and salamander larvae.

***Arundo* impacts:** Minimal impacts. Where *Arundo* occurs, there would be lower food resources as *Arundo* stands are less productive than native habitat.

Movement:

They are primarily diurnal. It is typically a pond frog, found in or near water, but can wander overland at times. It is sometimes found in damp places far from water, including cool and moist bushes and thickets. It is active all year except in wetlands that dry out in summer, where frogs will estivate in moist refuges until the late fall rains. Some adults inhabit the breeding pond all year, but other frogs disperse into other habitats and must travel overland some distance, usually on rainy nights, to get to the breeding pond. It is a good climber and has been observed climbing a 4 foot high plastic barrier.

***Arundo* impacts:** Dense stands could impede movement, but the two species have poor overlapping habitat types, so impacts are very minor.

Decline and Threats:

Total adult population size is unknown but undoubtedly exceeds 10,000. The species is still locally abundant in portions of the San Francisco Bay area and the central coast. Range has been reduced by 70%. Currently, area of occupancy, number of subpopulations, and population size probably are still declining, but the rate of decline is unknown.

Factors contributing to the decline include wetland destruction and degradation/fragmentation, urbanization, residential development, reservoir construction, stream channelization, livestock grazing of riparian vegetation, off-road vehicle activity, drought, overharvesting, and exotic fishes (bass, mosquitofish) and possibly bullfrogs. Declines in the red-legged frog complex have also have been attributed to global warming, UV-B radiation, airborne contaminants (pesticide drift), and disease. Wetland approved formulations of herbicides are not implicated in impacts to RLF or other amphibians.

Populations in the Sierra Nevada Mountains and in southern California have declined seriously, possibly due to introductions of non-native predators such as American Bullfrogs and introduced fish, including mosquitofish, habitat loss due to development and agriculture, and pesticide pollution. Windborne pollutants from agriculture in the Central Valley have probably contributed considerably to the extirpation of the species in the nearby Sierra Nevada foothills. Much of this frog's prime habitat of foothills grassland has been destroyed by development in the Bay Area and in the Sierra Nevada foothills. The role of the Chytrid fungus and of the introduced American Bullfrog in *Rana draytonii* declines are not well understood.

***Arundo* impacts:** For the central valley, RLFs are primarily restricted to higher foothills, where *Arundo* distribution is minimal stands are not typically large.

Status/Distribution or Historic and Current Range:

Endemic to California and northern Baja California. Historically, this species was found along the coast and Coast Ranges from Mendocino County in northern California south to northern Baja California, and inland east through the northern Sacramento Valley into the foothills of the Sierra Nevada mountains, south to Tulare county, and possibly Kern county. They probably did not occur in the central valley due to annual floods.

Range is now much reduced in the Sierra Nevada and in southern California, but the species is still present throughout much of its former range in the central California coast range. Elevational range extended from sea level to about 1,500 meters (5,000 feet); usually below 1,200 meters (3,935 feet).

***Arundo* overlap scores:** In the central valley RLFs occurrences are primarily in foothills above the majority of *Arundo* stands. RLFs overlapping with *Arundo* on only 1 of the 25 watershed units (Table 7-4). Overlap scores between *Arundo* and giant garter snake was low (2).

Sources:

Davidson, C., H.B. Shaffer, M.R. Jennings. 2001. Declines of the California red-legged frog: climate, UV-B, habitat, and pesticides hypotheses. Ecological Applications 11:464-479.

Fellers, G.M., P.M. Kleeman. 2007. California red-legged frog (Rana draytonii) movement and habitat implications for conservation. Journal of Herpetology 41:276-286.

Hammerson, G.. 2008. *Rana draytonii*. The IUCN Red List of Threatened Species 2008: e.T136113A4240307. http://dx.doi.org/10.2305/IUCN.UK.2008.RLTS.T136113A4240307.en.

Trumbo, J., D. Waligora. 2009. The impact of the herbicides imazapyr and triclopyr triethylamine on bullfrog tadpoles. California Fish and Game 95:122-127.

http://www.californiaherps.com/frogs/pages/r.draytonii.html

Valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*)

Federal status: Threatened

State status: None

Arundo impact score: 8/10 (Very High impact)

Alteration of abiotic structure and biological function, direct take possible.

General Ecological Needs/Habitat Affinities:

Valley elderberry longhorn beetles (VELB) are found in riparian habitat only in the vicinity of their host plant, the elderberry (*Sambucus* spp.). They are a subspecies that is restricted to California's Central Valley. Elderberry shrubs are common in the Central Valley where they grow naturally in a variety of riparian and non-riparian vegetative communities. Most elderberry presence within the Central Valley is determined by broad scale hydrologic regimes such as the relative elevation of floodplain and floodplain width, and secondarily by sediment texture and topography. They are most common on higher and older riparian terraces, where the roots of the plant are able to reach the water table and where the plants are not inundated for long periods. Elderberry shrubs can be found on historic floodplain terraces above the river, on levees (both on the river and land sides), and along canals, ditches, and areas where subsurface flow provides water to elderberry roots. They can be a canopy or sub-canopy species depending on the hydrology, vegetation composition, or disturbance at a particular site and it can occur as individual shrubs, clumps, clusters, and groves. In non-riparian settings, elderberries occur either singly or in groups in valley oak and blue oak woodland and annual grasslands. Elderberry shrubs can be a common understory plant in both non-riparian valley oak and blue oak woodland habitats. Elderberry shrubs are also often found away from riparian areas where ditches, irrigation, groundwater, or other features allow the plant to receive enough moisture and as ornamental plantings in regularly maintained landscaped areas.

At the local level, it appears that much of the variation in VELB occupancy of elderberry shrubs results from variables such as elderberry condition, water availability, elderberry density, and the health of the riparian habitat. This research indicates that healthy riparian systems supporting dense elderberry clumps are the primary habitat of VELB.

Much of the existing research has focused on the VELB's use of riparian habitat. In non-riparian habitats, a patchwork of individual shrubs provides opportunity for VELB occupancy, but it is unknown if the movement and distribution patterns remain consistent with the patterns found in riparian areas. In non-riparian areas, adverse effects to of VELB are likely to occur as a result of impacts to any elderberry shrub with exit holes, and adverse effects may result from disturbance to elderberry shrubs reasonably close to riparian areas or known VELB populations.

Research suggests that the VELB occurs throughout the Central Valley in metapopulations. Metapopulations are defined as a system of discrete subpopulations that may exchange individuals through dispersal or migration. The VELB metapopulation occurs throughout contiguous intact

riparian habitat as subpopulations that shift spatially and temporally within drainages, resulting in a patchwork of occupied and unoccupied habitat. Removal of suitable habitat (whether occupied or unoccupied) can increase the distance between occupied and unoccupied patches. Because its physical dispersal capability is limited, this fragmentation decreases the likelihood of successful colonization of unoccupied habitat. As a consequence, the subpopulations are more vulnerable to stochastic events that may reduce or eliminate the subpopulation. The loss of multiple subpopulations can have an adverse impact on the long-term persistence and health of the metapopulation. Therefore, maintaining contiguous areas of suitable habitat is critical for maintaining the VELB.

***Arundo* impacts:** *Arundo* and elderberry plants (host for VELB) have very similar habitat affinities. Both prefer episodic high energy flows, broad wide riverine systems with expansive floodplains and terraces. Neither species is particularly abundant in the dynamic active channel. Both species can occupy modified banks/levees, canals, or other habitats where water is present for at least a portion of the year. *Arundo* directly displaces elderberry plants, uses water that would be available to elderberry plants, and increases fire frequency and intensity, impacting both elderberry plants and VELB. *Arundo* also modifies geomorphological process, pushing systems that would be multi-channeled and laterally unstable to single, stable deep-channel structures. This would decrease natural riparian disturbance that elderberry plants respond to, lowering their abundance and distribution. Dense *Arundo* stands may also isolate plants and reproductive units. Fire in *Arundo* stands is documented in riparian habitat (Chapter 7). As fire risk increases with climate change, resulting dryer and hotter weather patterns, fire events will become more frequent and more intense. *Arundo* fires may already be resulting in VELB mortality at isolated locations, this trend may increase dramatically. *Arundo* increases risk of ignition via transient encampments, which frequently use *Arundo* stands for cover.

Breeding/Life History:

The VELB is a small (0.5 0.8 in.) wood-boring beetle in the *Cerambycid* family. It is sexually dimorphic and the females are indistinguishable from the more widespread California elderberry longhorn beetle (*Desmocerus californicus californicus*). Native elderberry shrubs (*Sambucus* spp.) are the obligate larval host plants for the VELB and their larvae go through several developmental stages (instars) within the elderberry shrub. Eggs are laid individually on leaves or at the junctions of the leaf stalk and main stem. Upon hatching, the larvae bore into the elderberry stem and create feeding galleries in the pith. Prior to pupation, the larvae creates an exit hole, plugs the hole with wood shavings, and returns to the gallery where it pupates. Approximately 1 month later, the adult beetle emerges from the stem through the previously created exit hole. Adult emergence, mating, and egg-laying, occurs in the spring and summer (March to July), typically coinciding with the elderberry flowering period. Under laboratory conditions, adult males typically live 4 to 5 days, while females can live up to 3 weeks. The only identifiable exterior evidence of elderberry use by VELB is the exit hole created by the larvae.

***Arundo* impacts:** Breeding and reproduction is diminished if there are fewer elderberry plants. Direct competition with *Arundo* plants decreases the number and size of plants. *Arundo*'s modification of the habitat reduce the distribution and abundance of elderberry plants. Areas that would have large healthy stands of elderberry are frequently occupied by dense stands of *Arundo* (and tamarisk).

Diet:

Leaves and flowers of the elderberry provide food for the adult beetle while the interior pith of elderberry stems and roots at least one inch in diameter provides both food and shelter for the developing larva.

***Arundo* impacts:** *Arundo* directly displaces elderberry plants which are food for VELB. Significant abiotic impacts reduce habitat suitability for elderberry plants.

Movement:

The species is nearly always found on or close to its host plant. Larvae burrow into the stems. The physical dispersal capability of the VELB is limited. Research suggests that the VELB occurs throughout the Central Valley in metapopulations. Metapopulations are defined as a system of discrete subpopulations that may exchange individuals through dispersal or migration. The VELB metapopulation occurs throughout contiguous intact riparian habitat as subpopulations that shift spatially and temporally within drainages, resulting in a patchwork of occupied and unoccupied habitat.

Elderberry shrubs typically have a clumped distribution across the landscape, although they can occur singly. Upon emergence, VELB typically stay within the local clump. It was found that much of the time, distances between stems with exit holes averaged 25-50 meters (65-165 feet) apart. At larger scales, average distances between these occupied clumps ranged from 200 meters (656 feet) up to 800 meters (2,625 feet).

***Arundo* impacts:** *Arundo* can physically isolate elderberry plants as well as reduce plant density so that plants become too scattered. VELB have a limited dispersal capability, so this isolates populations.

Decline and Threats:

Because the elderberry is the sole host plant of the VELB, any activities that adversely impact the elderberry shrub may also adversely impact the VELB. Adverse impacts to elderberry shrubs can occur either at a habitat scale or at an individual shrub scale. Activities that reduce the suitability of an area for elderberry plants or elderberry recruitment and increase fragmentation may have adverse impacts to mating, foraging, and dispersal of VELB. The patchy nature of VELB habitat and habitat use makes the species particularly susceptible to adverse impacts from habitat fragmentation.

Extensive destruction of California's Central Valley riparian forests has occurred during the last 150 years due to agricultural and urban development. According to some estimates, riparian forest in the Central Valley have declined by as much as 89 percent during that time period. The valley elderberry longhorn beetle, though wide-ranging, is in long-term decline due to human activities that have resulted in widespread alteration and fragmentation of riparian habitats, and to a lesser extent, upland habitats, which support the beetle.

The primary threats to survival of the beetle include: loss and alteration of habitat by agricultural conversion, inappropriate grazing, levee construction, stream and river channelization, removal of riparian vegetation and rip-rapping of shoreline, non-native animals such as the Argentine ant, which may eat the early phases of the beetle, and recreational, industrial and urban development.

Insecticide and herbicide use in agricultural areas and along road right-of-ways may be factors limiting the beetle's distribution. The age and quality of individual elderberry shrubs/trees and stands as a food plant for beetle may also be a factor in its limited distribution.

***Arundo* impacts:** Significant *Arundo* impacts to abiotic and biotic processes are reducing the distribution and abundance of elderberry plants, the host plant for VELB.

Status/Distribution or Historic and Current Range:

The range of the VELB extends from approximately Shasta County in the north to Fresno County in the south including the valley floor and lower foothills. The majority of VELB have been documented below 152 meters (500 feet) in elevation. Areas above 152 meters with suitable habitat and known VELB occurrences in that drainage may contain VELB populations in certain circumstances.

The historic distribution of the VELB closely matched the distribution of the elderberry host plant, which was patchily found throughout the Central Valley riparian forests and occasionally adjacent uplands (non-riparian).

***Arundo* overlap scores:** The VELB is widely distributed in the Central Valley overlapping with *Arundo* on 23 of the 25 watershed units (Table 6-5). This sensitive species has the widest distribution in the study. Overlap scores between *Arundo* and VELB were typically moderate to high, but some units scored low (2 to 9).

Sources:

Collinge, S.K., M. Holyoak, C.B. Barr, J.T. Marty. 2001. Riparian habitat fragmentation and population persistence of the threatened valley elderberry longhorn beetle in central California. Biological Conservation 100:103-113.

Huxel, G.R. 2000. The effect of the Argentine ant on the threatened valley elderberry longhorn beetle. Biological Invasions 2:81-85.

US Fish and Wildlife Service Species page: https://www.fws.gov/sacramento/es_species/Accounts/Invertebrates/valley_elderberry_longhorn_beetle/

https://www.epa.gov/sites/production/files/2013-08/documents/elderberry-lh-beetle_0.pdf

U.S. Fish and Wildlife Service. 2017. Framework for Assessing Impacts to the Valley Elderberry Longhorn Beetle (*Desmocerus californicus dimorphus*). U.S. Fish and Wildlife Service; Sacramento, California. 28pp.

Riparian (San Joaquin) woodrat (*Neotoma fuscipes riparia*)

Federal status: Endangered

State status: None

Arundo impact score: 6/10 (Moderate/High impact)

Moderate alteration of abiotic structure and/or biological function (impacts on general ecological needs, reproduction, diet, or movement).

General Ecological Needs/Habitat Affinities:

The riparian woodrat is a subspecies of the dusky- footed woodrat restricted to the Central Valley that inhabits live oaks and other thick-leaved, evergreen trees and shrubs, making large middens near their bases. They are most numerous where shrub cover is dense and least abundant in open areas. In riparian areas, highest densities of woodrats and their houses are often encountered in willow thickets with an oak overstory.

***Arundo* impacts:** *Arundo* displaces native vegetation that woodrats prefer, and *Arundo* increases the risk (increases risk of ignition via transient encampments) and severity of fire. These are significant impacts.

Breeding/Life History:

This woodrat builds a house of debris on the ground or in a tree; houses tend to be in situations that are shaded, relatively cool, and in good cover, and they may be used by many generations over several years. After breeding, males live in tree dens apart from females. Most young are born from February (especially in south) to May. Gestation lasts 30-37 days. Usually one litter per year.

Predators include hawks, owls, bobcat, coyote, long-tailed weasel, etc.

***Arundo* impacts:** Riparian woodrats prefer a dense woody plant overstory. *Arundo* has very poor structure for woodrat dens, as canes are dense and upright. Areas that are between or under *Arundo* canopy fill in with *Arundo* canes over time, which would impact dens constructed there. Many woodrats are found on the Salinas River, although a different species, they rarely make dens in *Arundo* stands. Dens are in dense native woody vegetation. *Arundo* stands are low value habitat.

Diet:

Diet includes a wide variety of plants and also seeds, nuts, acorns, fruits, green vegetation, inner bark, and fungi. This woodrat stores food.

***Arundo* impacts:** *Arundo* has no seeds, fruits, or vegetative material that woodrats have been observed to eat. *Arundo* displaces vegetation that would be of higher food value. *Arundo* stands negatively impact diet and food resources.

Movement:

The woodrat is primarily nocturnal. One study found that each woodrat averaged 1.8 houses/home range. Loosely colonial, with partially overlapping home ranges; several individuals may live in the same area, though individuals (aside from females with young) typically live in separate houses. Adult home range averages around 2,000 sqm.

***Arundo* impacts:** *Arundo* stands could impede movement through habitat causing fragmentation of the useable habitat space within an individual's territory.

Decline and Threats:

Predators include hawks, owls, bobcat, coyote, long-tailed weasel, etc. Generally populations are negatively affected by grazing and the removal of undergrowth or shrubby vegetation, but these are not major threats to the species overall.

By the mid-1980s, the riparian forest community of the San Joaquin Valley had been reduced to only about 5.8 percent of its original extent. Thus, loss and fragmentation of habitat are the principal reasons for the decline of the riparian woodrat. Much of this loss was the result of the construction of large dams and canals which diverted water for the irrigation of crops and permanently altered the hydrology of Valley streams. More was lost through cultivation of the river bottoms. Historically, cattle also probably impacted riparian woodrat populations since the thick undergrowth, which is particularly important to woodrats, is sensitive to trampling, browsing and grazing by livestock.

***Arundo* impacts:** *Arundo* could add to generalized impacts on the species. Fire would be a new and catastrophic impact that would be a greater risk due to *Arundo*, both in terms of fire intensity and risk of ignition (due to transient encampments).

Status/Distribution or Historic and Current Range:

The only population that has been verified is the single, known extant population restricted to about 100 hectares (250 acres) of riparian forest on the Stanislaus River in Caswell Memorial State Park. It was estimated in 1993 that the size of this population was 437 individuals.

***Arundo* overlap scores:** The riparian woodrat is the most restricted species in the Central Valley overlapping with *Arundo* on 1 of the 25 watershed units (Table 6-5). Overlap score between *Arundo* and riparian woodrat is moderate (4). There is very little *Arundo* in the known habitat area, but there is *Arundo* upstream of the known population of riparian woodrats. Other rivers and riparian areas that could support the rat also have *Arundo*.

Sources:

California State University Stanislaus Endangered Species Recovery Program, http://esrp.csustan.edu/publications/pubhtml.php?doc=sjvrp&file=chapter02M04.html

Cassola, F. 2016. *Neotoma fuscipes*. The IUCN Red List of Threatened Species 2016: e.T14587A22371665. http://dx.doi.org/10.2305/IUCN.UK.2016-2.RLTS.T14587A22371665.en. Downloaded on 13 April 2018.

U.S. Fish & Wildlife Service. 1997. Draft Recovery Plan for Upland Species of the San Joaquin Valley, California. U.S. Fish and Wildlife Service, Region 1, Portland OR.

Riparian brush rabbit (*Sylvilagus bachmani riparius*)

Federal status: Endangered

State status: Endangered

Arundo impact score: 6 out of 10 Moderate/High impact

Moderate alteration of abiotic structure and/or biological function (impacts on general ecological needs, reproduction, diet, or movement).

General Ecological Needs/Habitat Affinities:

Riparian brush rabbits live in the brushy understory of valley riparian forests. Forest with a closed canopy, however, generally lacks sufficient understory of shrubs for their needs. Where mats of low growing wild roses, wild grape (*Vitis californica*), and blackberries are found in *savanna*-like settings, brush rabbits live in tunnels through the vines and shrubs.

Sites inhabited by riparian brush rabbits usually have a mix of roses, blackberries, marsh baccharis, and grape vines, with high volumes of roses and coyote bushes (*Baccharis* sp.) in comparison to uninhabited sites.

***Arundo* impacts:** *Arundo* displaces native vegetation that brush rabbits prefer, and *Arundo* increases the risk of fire (via transient encampments in *Arundo*) and severity of fire events. These are significant impacts. Brush rabbits prefer a very dense scrub and vine cover. *Arundo* has very poor structure for understory habitat, as canes are upright and so dense in mature stands that they would limit movement. Areas that are between or under *Arundo* canopy fill in with *Arundo* canes over time, which could impact trail systems.

Breeding/Life History:

Breeding of riparian brush rabbits is restricted to approximately January to May. On average, a female may produce 9 to 16 young each year.

***Arundo* impacts:** Brush rabbits prefer a very dense plant cover of shrubs and vines for breeding and foraging. *Arundo* displaces this cover.

Diet:

Riparian brush rabbits frequent small clearings where they feed on a variety of herbaceous vegetation, including grasses, sedges, clover, forbs, shoots, and leaves. Grasses and other herbs are the most important food for brush rabbits, but shrubs such as California wild rose (*Rosa californica*), marsh baccharis (*Baccharis douglasii*), and California blackberry (*Rubus ursinus*) also are eaten. When available, green clover (*Trifolium wormskioldii*) is preferred over all other foods.

***Arundo* impacts:** *Arundo* has no seeds, fruits, or vegetative material that mammals would in general consume (foliage has a high concentration of silica). *Arundo* displaces vegetation that would be of higher food value. *Arundo* stands negatively impact diet and food resources.

Movement:

Riparian brush rabbits are most active during the twilight hours around dawn and dusk. Depending on season, the main activity periods last 2 to 4 hours. The least activity is from about 10:30 a.m. to 4:00 p.m

***Arundo* impacts:** *Arundo* has poor structure for understory habitat, as canes are tall, upright, and so closely spaced in mature stands that they block movement. Areas that are between or under *Arundo* canopy fill in with *Arundo* canes over time, which impacts trail systems.

Decline and Threats:

Two phenomena jointly have been the primary cause of the decline of the riparian brush rabbit. The first was the destruction and fragmentation of the San Joaquin Valley riparian forest by conversion to various urban and agricultural uses, and its degradation through a variety of other human activities. By the mid-1980s, this community had been reduced to only about 5.8 percent of its original extent. The second was the conversion of land within the floodplains from shrub-dotted pastureland to vineyards, orchards, and row crops, with attendant land clearing and leveling, and the building and maintenance of levees. The land along rivers no longer exhibits the small patches of shrub-covered upland that once provided rabbits refuge from flooding and predation.

The primary threat to the survival of the riparian brush rabbit is the limited extent of its existing habitat and the fact that there is only one extant population.

The long-term suppression of fire in Caswell Memorial State Park, combined with prolonged drought, has caused the buildup of high fuel loads. The dense, brushy habitat to which the rabbits are restricted is thus highly susceptible to catastrophic wildfire that would cause both high mortality and severe destruction of habitat. Recovery of the riparian brush rabbit population from such a devastating event would be improbable.

Like most rabbits, the riparian brush rabbit is subject to a variety of common diseases, including tularemia, plague, myxomatosis, silverwater, encephalitis, listeriosis, Q-fever, and brucellosis. These

contagious, and generally fatal, diseases could be transmitted easily to riparian brush rabbits from neighboring populations of desert cottontails.

***Arundo* impacts:** *Arundo* stands add to generalized impacts on the species. *Arundo* increases the risk of fire (via transient encampments in *Arundo*) and severity of fire events.

Status/Distribution or Historic and Current Range:

Historically, the riparian brush rabbit is believed, based on the presence of suitable habitat, to have been found associated with riparian forests along portions of the San Joaquin River and its tributaries on the Valley floor, from at least Stanislaus County to the Delta.

By the mid-1980s, the riparian forest within the former range of the riparian brush rabbit had been reduced to a few small and widely scattered fragments. At 104.5 hectares (258.2 acres), Caswell Memorial State Park, on the Stanislaus River in southern San Joaquin County, is the largest remaining fragment of suitable riparian forest and home to the only extant population of riparian brush rabbit. Brush rabbits have been re-introduced to several sites in the region.

***Arundo* overlap scores:** The riparian brush rabbit is a very restricted species in the Central Valley, overlapping with *Arundo* on 4 of the 25 watershed units (Table 6-5). Overlap scores between *Arundo* and riparian brush rabbit is moderate (1 to 4). There is very little *Arundo* in the known habitat area, but there is *Arundo* upstream of the known population of riparian brush rabbits. Sites that have had re-introductions in the region also have *Arundo* both within sites and above the sites. Other rivers that could support the brush rabbits also have *Arundo*.

Sources:

California State University Stanislaus Endangered Species Recovery Program
http://esrp.csustan.edu/publications/pubhtml.php?doc=sjvrp&file=chapter02M07.html

http://www.iucnredlist.org/details/41302/0

U.S. Fish & Wildlife Service. 1997. Draft Recovery Plan for Upland Species of the San Joaquin Valley, California. U.S. Fish and Wildlife Service, Region 1, Portland OR.

San Joaquin kit fox (*Vulpes macrotis mutica*)

Federal status: Endangered

State status: Threatened

Arundo impact score: 3/10 (Low impact)

Slight or potential alteration of biological function (impacts on general ecological needs, reproduction, diet, or movement).

General Ecological Needs/Habitat Affinities:

In the southernmost portion of its range, the San Joaquin kit fox is commonly associated with Valley Sink Scrub, Valley Saltbush Scrub, Upper Sonoran Subshrub Scrub, and Annual Grassland. Kit foxes also inhabit grazed grasslands, petroleum fields, urban areas, and survive adjacent to tilled or fallow fields. In the central portion of the range, the kit fox is associated with Valley Sink Scrub, Interior Coast Range Saltbush Scrub, Upper Sonoran Subshrub Scrub, Annual Grassland and the remaining native grasslands. Agriculture dominates this region where kit foxes mostly inhabit grazed, non-irrigated grasslands, but also live next to and forage in tilled or fallow fields, irrigated row crops, orchards, and vineyards. In the northern portion of their range, kit foxes commonly are associated with annual grassland and Valley Oak Woodland. Kit foxes inhabit grazed grasslands, grasslands with wind turbines, and also live adjacent to and forage in tilled and fallow fields, and irrigated row crops (Bell 1994).

Kit foxes use some types of agricultural land where uncultivated land is maintained, allowing for denning sites and a suitable prey base. Kit foxes also den on small parcels of native habitat surrounded by intensively maintained agricultural lands and adjacent to dryland farms.

San Joaquin kit foxes use dens for temperature regulation, shelter from adverse environmental conditions, reproduction, and escape from predators. Though kit foxes are reputed to be poor diggers, the complexity and depth of their dens do not support this assessment. Kit foxes also modify and use dens constructed by other animals, such as ground squirrels, badgers, and coyotes, and human-made structures (culverts, abandoned pipelines, and banks in sumps or roadbeds)

***Arundo* impacts:** Kit foxes do not favor riparian habitat, but may use riparian areas as corridors for movement. *Arundo* stands can impede this movement. Smaller tributaries can have banks suitable for denning, which could be blocked or impacted by *Arundo*.

Breeding/Life History:

Adult pairs remain together all year, sharing the home range but not necessarily the same den. During September and October, adult females begin to clean and enlarge natal or pupping dens. Mating and conception take place between late December and March. Litters of from two to six pups are born sometime between February and late March. Kit foxes can breed when 1 year old, but may not breed their first year of adulthood.

***Arundo* impacts:** *Arundo* stands could reduce access and suitability of ephemeral stream and creek banks for denning locations. *Arundo* stands are typically scattered in these low energy ephemeral streams, so the effect is minor.

Diet:

Diet of kit foxes varies geographically, seasonally, and annually, based on variation in abundance of potential prey. They eat kangaroo rats, pocket mice, white-footed mice (*Peromyscus* spp.), other nocturnal rodents, California ground squirrels, San Joaquin antelope squirrels black-tailed hares, San Joaquin antelope squirrels, desert cottontails, ground-nesting birds, and insects. Vegetation and insects occur frequently in feces. Grass is the most commonly ingested plant material.

***Arundo* impacts:** Riparian areas are not the primary hunting areas for kit foxes, but they may be used seasonally. Minor impacts to food availability, due to *Arundo*'s lower habitat value.

Movement:

Home range size varies from 251 ha to 1160 ha and generally does not differ between sexes. Size can vary with habitat conditions, particularly food availability. Kit foxes are primarily nocturnal and nightly movements exceeding 14 km have been reported. Though kit foxes are predominantly nocturnal, kit foxes are commonly seen during the day during late spring and early summer.

Kit foxes use dens year-round and uses include daytime resting, escaping predators, avoiding temperature extremes, conserving moisture, and bearing and rearing young. Dens are distributed throughout home ranges, and an individual fox typically uses over 11 dens during a given year.

***Arundo* impacts:** Riparian corridors, particularly small streams and creeks are likely used to move across the landscape. *Arundo* may physically impede this movement.

Decline and Threats:

Researchers since the early 1970s have implicated predation, starvation, flooding, disease, and drought as natural mortality factors. Shooting, trapping, poisoning, electrocution, road kills, and suffocation have been recognized as human-induced mortality. By the 1950s the principal factors in the decline of the San Joaquin kit fox were loss, degradation, and fragmentation of habitats associated with agricultural, industrial, and urban developments in the San Joaquin Valley

Loss and degradation of habitat by agricultural and industrial developments and urbanization continue, decreasing carrying capacity of remaining habitat and threatening kit foxes. Livestock grazing is not thought to be detrimental to kit foxes but may alter the numbers of different prey species, depending on the intensity of the grazing. Livestock grazing may benefit kit foxes in some areas, but grazing that destroys shrub cover and reduces prey abundance may be detrimental.

***Arundo* impacts:** *Arundo* may exacerbate flooding and drought in portions of fox habitat. Expansion of fire, particularly riparian fires tied to transient camps could impact foxes. Transient camps also bring feral dogs into wildland areas. *Arundo* is positively corelated with increased density of encampments, as it offers cover.

Status/Distribution or Historic and Current Range:

Prior to 1930, kit foxes inhabited most of the San Joaquin Valley from southern Kern County north to Tracy, San Joaquin County, on the west side, and near La Grange, Stanislaus County, on the east side. Kit foxes currently inhabit some areas of suitable habitat on the San Joaquin Valley floor and in the surrounding foothills of the coastal ranges, Sierra Nevada, and Tehachapi Mountains, from southern Kern County north to Contra Costa, Alameda, and San Joaquin Counties on the west, and near La Grange, Stanislaus County on the east side of the Valley and some of the larger scattered islands of natural land on the Valley floor in Kern, Tulare, Kings, Fresno, Madera, and Merced Counties. Kit foxes also occur westward into the interior coastal ranges in Monterey, San Benito, and Santa Clara Counties (Pajaro River watershed), in the Salinas River watershed, Monterey and San Luis Obispo Counties, and in the upper Cuyama River watershed in northern Ventura and Santa Barbara Counties and southeastern San Luis Obispo County.

***Arundo* overlap scores:** *Arundo* is present in the San Joaquin Valley floor as well as creek corridors extending into the foothills. The kit fox is found on every watershed unit, but one, in the San Joaquin Valley, overlapping with *Arundo* on 8 of the 25 watershed units (Table 6-5). Overlap scores between *Arundo* and kit fox range from moderate to high (3 to 8).

Sources:

Haight, R.G., B. Cypher, P.A. Kelly, S. Phillips, K. Ralls, H. Possingham. 2004. Optimizing reserve expansion for disjunct populations of San Joaquin kit fox. Biological Conservation 117:61-72.

U.S. Fish & Wildlife Service. 1997. Draft Recovery Plan for Upland Species of the San Joaquin Valley, California. U.S. Fish and Wildlife Service, Region 1, Portland OR.

http://esrp.csustan.edu/publications/pubhtml.php?doc=sjvrp&file=chapter02L00.html

Salt-marsh harvest mouse (*Reithrodontomys raviventris*)

Federal status: Endangered

State status: Endangered

IUCN status: Endangered

Arundo impact score: 3/10 (Very Low/Improbable impact)

Slight or potential alteration of biological function (impacts on general ecological needs, reproduction, diet, or movement).

General Ecological Needs/Habitat Affinities:

Salt marshes are the optimal habitat for this species, in particular those that support dense stands of pickleweed and are adjacent to upland, salt-tolerant vegetation, for escape during high tides. The

ability to tolerate high salinity in both food (grasses, forbs, seeds, and insects) and water, and the ability to swim and climb enable this mouse to take advantage of its unique habitat. However, the once extensive marshes of San Francisco, San Pablo and Suisun Bays are now extremely fragmented. Of the 193,800 acres of tidal marsh existing in the 1850s, only about 30,100 remain. Some of the marshes have been pared to remnants that are totally flooded by high tides, leaving no high-ground retreat in which the salt marsh harvest mouse might take refuge. Any rise in sea level combined with a reduction of sediment deposition resulting from upstream dams and water diversions would contribute to the loss of more salt marsh habitat.

***Arundo* impacts:** Minor impacts from *Arundo* degrading refugia riparian habitat used during high water events. *Arundo* stands in areas adjacent to estuaries can drape over and onto marsh habitat, particularly along engineered structures such as dikes, levees and berms. *Arundo* biomass could also be deposited in brackish marsh habitat, degrading native vegetation that that the harvest mouse depends on.

Breeding/Life History:

The life span of the salt marsh harvest mouse is about 8 to 12 months. This requires that the population renew itself every year in order to survive. While sexually active from March to November, females often bear only one of the three possible litters, and litters of only four offspring are typical. If there is a nest, it is only a loose ball of grasses on the surface of the ground. The salt marsh harvest mouse does not burrow. It is vulnerable to snakes, owls, hawks, and cats. Young salt marsh harvest mice can disperse a considerable distance, but not from fragmented habitat across bare or converted environs.

***Arundo* impacts:** Minor *Arundo* impacts where marsh habitat is degraded by *Arundo* biomass or *Arundo* stands draping over from adjacent habitat and covering marsh habitat. This does occur along levees and dikes, which can have very dense bands of *Arundo* growing on them.

Diet:

The diet consists mainly of green vegetation, including pickleweed, with a higher proportion of fresh green grasses consumed in winter, and some seeds and insects also eaten.

***Arundo* impacts:** Minor impacts from *Arundo* biomass and stands on dikes, levees and berms.

Movement:

The salt-marsh harvest mouse is usually nocturnal and is active all year. In addition to being an agile climber, it may also use runways along the ground, and is able to swim well. Young salt marsh harvest mice can disperse a considerable distance, but not from fragmented habitat across bare or converted environs.

***Arundo* impacts:** *Arundo* stands on levees and berms may interfere with movement across the landscape. *Arundo* biomass deposited in areas after flooding, may also be an obstacle to movement.

Decline and Threats:

Its former probably more or less continuous historical distribution has been fragmented, leaving harvest mouse populations restricted to discontinuous patches of suitable habitat. About 84% of historical tidal marshes of the San Francisco Bay area have been destroyed. Over 3,600 acres of habitat have been filled or degraded since the 1970s.

This species is threatened by habitat destruction or disturbance due to development, residential encroachment, intrusion of fresh water into salt marshes, marsh subsidence, and predation (especially by housecats). In many marsh habitats, there is no higher ground to escape to during high tides. Remaining populations are relatively small, isolated, and may lack the size and full range of resources needed for long-term persistence.
Threats include continued loss of habitat to development, pollution and other changes in water quality, and encroachment by exotic plant species (e.g., invasive cordgrasses, *Spartina*) that do not provide suitable habitat for salt marsh harvest mice. Most areas of remaining habitat support few to no mice because of backfilling, subsidence, or vegetation changes.

***Arundo* impacts:** No additional impacts.

Status/Distribution or Historic and Current Range:

Once the salt-marsh harvest mouse ranged along the central coast of California. It was concentrated, as it still is, in the salt marshes of the San Francisco Bay area. However, today the mouse's populations are smaller and isolated from each other, largely due to human activities. The northern subspecies inhabits marshes around San Pablo Bay and up the Petaluma River to the Petaluma Marsh, marshes around Suisun Bay east to the Delta of the San Joaquin and Sacramento River, and still other marshes, including some south on the Marin Peninsula. This area includes lands in the San Pablo Bay National Wildlife Refuge (NWR) and lands protected and managed under the Suisun Marsh Preservation Agreement. Suisun Marsh is the largest contiguous brackish water marsh remaining on the West Coast. The southern subspecies is found in the marshes around the southern and southeastern shore of San Francisco Bay. This includes land in the San Francisco Bay NWR.

***Arundo* overlap scores:** *Arundo* is scattered in the Delta area where salt-marsh harvest mice have been observed. The salt-marsh harvest mouse is only found on two watershed units, overlapping with *Arundo* on 2 of the 25 watershed units (Table 6-5). Overlap scores between *Arundo* and salt-marsh harvest mouse range from low to moderate (2 to 5).

Sources:

Bias, M.A., M.L. Morrison. 2010. Habitat selection of the salt marsh harvest mouse and sympatric rodent species. Journal of Wildlife Management 70:732-742.

U.S. Fish & Wildlife Service. 1997. Draft Recovery Plan for Upland Species of the San Joaquin Valley, California. U.S. Fish and Wildlife Service, Region 1, Portland OR.

Whitaker Jr., J.O. & NatureServe (Hammerson, G. & Williams, D.F.). 2008. *Reithrodontomys raviventris*. The IUCN Red List of Threatened Species 2008: e.T19401A8875959. http://dx.doi.org/10.2305/IUCN.UK.2008.RLTS.T19401A8875959.en.

https://www.arkive.org/saltmarsh-harvest-mouse/reithrodontomys-raviventris/

https://www.epa.gov/sites/production/files/2013-08/documents/salt-marshharvest-mouse.pdf

Buena Vista Lake ornate shrew (*Sorex ornatus relictus*)

Federal status: Endangered

State status: None

Arundo impact score: 2/10 (Very Low impact)

Potential alteration of biological function (impacts on general ecological needs, reproduction, diet, or movement).

General Ecological Needs/Habitat Affinities:

Buena Vista Lake shrews occupied Valley Freshwater Marshes on the perimeter of Buena Vista Lake and probably occurred throughout the Tulare Basin, though most of the marshlands were drained or dried up prior to the discovery of the shrew in 1932. Recent captures on the Kern Lake Preserve occurred in areas with a dense wetland vegetative cover and an abundant layer of detritus. Plant species associated within these areas include Fremont cottonwood (*Populus fremontii*), willows (*Salix* spp.), glasswort, alkali heath, wild-rye grass *Elymus* sp.), and dense patches of Baltic and other rushes (*Juncus balticus*) and cattails.

***Arundo* impacts:** *Arundo* could impact riparian portions of the shrew's habitat. *Arundo* does not favor wetter marsh areas. *Arundo*, if abundant, could reduce available water degrading marsh areas.

Breeding/Life History:

Very little is known about the reproduction and mating system of the Buena Vista Lake shrew. The breeding season of the Buena Vista Lake shrew may begin in autumn and end with the onset of the dry season in May or June. In high-quality habitat in permanent wetlands, the breeding season may be extended. Up to two litters are produced per year containing four to six young.

***Arundo* impacts:** *Arundo* could impact the quality of habitat through water use and potential increased fire risk.

Diet:

The specific feeding and foraging habits of the Buena Vista Lake shrew are unknown. In general, shrews primarily feed on insects and other animals, mostly invertebrates. Food probably is not

cached and stored, so the shrew must forage periodically day and night to maintain its high metabolic rate.

***Arundo* impacts:** *Arundo* could impact the quality of habitat through generalized reduction of habitat value. *Arundo* is a poor food resource.

Movement:

Ornate shrews are active day and night.

***Arundo* impacts:** No impact.

Decline and Threats:

Loss and fragmentation of habitat are the major causes for decline and threat to the Buena Vista Lake shrew's survival. The conversion of natural lands to agriculture and diversion of fresh water supplies have eliminated most of the riparian habitat that once supported the shrew, reducing the subspecies to what may be a single remaining population. Buena Vista Lake is now cultivated, and Kern Lake has been reduced to 33 acres with a small pond and artificially-maintained wetland, and a more xerophytic community of annual and perennial saltbushes, saltgrass, and annual grasses and forbs.

***Arundo* impacts:** Minor impacts as *Arundo* does not favor this low energy riverine system.

Status/Distribution or Historic and Current Range:

The Buena Vista Lake shrew formerly occurred in wetlands around Buena Vista Lake, and presumably throughout the Tulare Basin. As early as 1933, the distribution of this species was already found to be much restricted due to the disappearance of lakes and sloughs. Since 1933 Buena Vista Lake and the surrounding lakes and Valley Freshwater Marshes have been drained and cultivated. Little is known about the current distribution of the Buena Vista Lake shrew. It was rediscovered in 1986 by Robert Hansen during excavations on the Kern Lake Preserve. The Buena Vista Lake shrew is a limited local endemic subspecies, has never been found to be locally abundant, and lives in very restricted areas of marshy wetland habitat. While the species still occurs within its limited range, it is not known whether or not the population is declining, how habitat conditions may be affecting the population, nor how small population size may be affecting genetic and behavioral stability.

***Arundo* overlap scores:** *Arundo* is very scattered in the upper San Juaquin Valley area where the Buena Vista Lake shrew have been observed. The shrew is found on four watershed units, overlapping with *Arundo* on 4 of the 25 watershed units (Table 6-5). Overlap scores between *Arundo* and shrew range from low to moderate (2 to 3).

Sources:

Cypher, B., E. Tennant, J. Maldonado, L. Saslaw, T. Westall, J. Mohay, E. Kelly, C. Van Horn Job. 2017. Conservation of endangered Buena Vista Lake shrews (Sorex ornatus relictus) through

investigation of taxonomic status, distribution, and use of non-invasive survey methods. http://esrp.csustan.edu/publications/pdf/Cypher_etal_2017_BVLS_Conservation.pdf

U.S. Fish & Wildlife Service. 1997. Draft Recovery Plan for Upland Species of the San Joaquin Valley, California. U.S. Fish and Wildlife Service, Region 1, Portland OR.

Mason's lilaeopsis (*Lilaeopsis masonii*)

Federal status: None

State status: None

CRPR listing: 1B.1

Arundo impact score: 5/10 (Moderate impact)

Minor alteration of abiotic structure and/or moderate alteration of biological function (impacts on general ecological needs, reproduction, diet, or movement).

General Ecological Needs/Habitat Affinities:

Mason's lilaeopsis is a perennial rhizomatous herb. It grows in regularly flooded tidal zones, on mud-banks and flats along erosional creek-banks, sloughs, and rivers, and in freshwater marshes, brackish marshes, and riparian scrub areas that are influenced by saline water. It is a colonizing species, so it is one of the first species to begin growing on newly deposited or exposed sediments. Many populations are therefore ephemeral, exploiting these areas. Mason's lilaeopsis occurs with other rare plants such as Suisun Marsh aster (*Aster lentus*), and delta tule pea (*Lathyrus jepsonii var. jepsonii*).

***Arundo* impacts:** Although *Arundo* does not directly grow (rooted in) in the estuarine/marsh substrate that Mason's lilaeopsis grows, *Arundo* directly displaces habitat areas by dense stands overhanging and physically accumulating over mudflat edges that occur against levees, berms and dikes where *Arundo* is abundant. *Arundo* debris, cane biomass, may also cover newly deposited or exposed sediment after flooding, which is Mason's lilaeopsis's primary niche. These impacts can be locally significant, but overall impact score is reduced to reflect impacts occurring only where marsh tidal areas interact with adjacent riparian and berm habitat. In some areas this can be a large proportion of exposed marsh habitat, in other areas these areas are a fraction of marsh/estuary habitat.

Breeding/Life History:

It may bloom between April and November. Rhizome fragments could be a mechanism in colonization and establishment of new populations.

***Arundo* impacts:** No specific impacts related to flowering and seed set. But *Arundo* stands can cover substrate along marsh edges, and *Arundo* debris can cover newly exposed and deposited sediment, where both seed germination and rhizome fragments would allow lilaeopsis plants to establish.

Decline and Threats:

It is threatened by erosion, channel stabilization, development, flood control projects, recreation, agriculture, shading resulting from marsh succession, and competition with non-native *Eichhornia crassipes*.

***Arundo* impacts:** *Arundo* exacerbates many of these processes including: erosion, flooding, and modification of habitat to reduce flooding.

Status/Distribution or Historic and Current Range:

The total known population for this species is represented by approximately 155 occurrences throughout its entire known range. It is locally abundant in some areas where it occurs. Populations of Mason's lilaeopsis are known from all parts of Suisun Marsh and around Mare Island, from Dutchman's Slough in the west to Collinsville Slough in the east, and from Roe Island and Van Sickle Island in the south to Peytonia Slough in the north. It is also present in Barker Slough within the Jepson Prairie Preserve. It is found in counties of Alameda, Contra Costa, Marin, Napa, Sacramento, San Joaquin, Solano, and Yolo.

***Arundo* overlap scores:** *Arundo* and Mason's lilaeopsis both occur in the Delta region, overlapping with *Arundo* on 4 of the 25 watershed units (Table 6-5). Overlap scores between *Arundo* and lilaeopsis range from moderate to high (3 to 7).

Sources:

CNPS Inventory of Rare and Endangered Plants http://www.rareplants.cnps.org/detail/974.html

Hart, J., J. Hunter. 2004. Restoring slough and riverbanks with biotechnical methods in the Sacramento-San Joaquin Delta. Ecological Restoration 22:262-268.

Natural Community and Species Accounts, Solano HCP Public Draft, July 2011, by LSA Associates, Inc. for Solano County Water Agency. http://www.scwa2.com/home/showdocument?id=754

UC Berkeley Jepson Herbarium http://ucjeps.berkeley.edu/eflora/eflora_display.php?tid=30919

Delta tule pea (*Lathyrus jepsonii* var. *jepsonii*)

Federal status: None

State status: None

CRPR status: 1B.2

Arundo impact score: 6/10 (Moderate impact)

Moderate alteration of abiotic structure and/or biological function (impacts on general ecological needs, reproduction, diet, or movement).

General Ecological Needs/Habitat Affinities:

The delta tule pea is generally found on brackish and freshwater marsh and slough edges. It can take root in appropriate habitat and climb to neighboring upland and riparian areas. Associate species include the California wildrose (*Rosa californica*), cattails (*Typha* spp.), and the common tule (*Scirpus acutus*).

***Arundo* impacts:** *Arundo* does not usually grow in standing water in brackish marsh and slough habitat, it does occur along marsh/slough edges. These marsh/slough edge *Arundo* stands can drape over the marsh/slough, reducing the amount of marsh edge habitat that can be occupied by the Delta tule pea. This is often a narrow band of habitat, as water becomes too deep for plants to establish in the wetter portions of the marsh, particularly more terrestrial plants that are dependent on seedling establishment.

Breeding/Life History:

The delta tule pea is a perennial herb with a vine-like habit in the pea family (Fabaceae). It depends on a cycle of flooded and dry periods in freshwater or brackish wetlands. It generally grows along the edges of riparian wetlands, sloughs, marshes, and swamps and blooms showy pink flowers from May through July and, in some years, as late as September.

***Arundo* impacts:** *Arundo* stands directly compete/displace habitat areas where Delta tule pea seedlings could establish. *Arundo* debris after flooding could also cover open substrate.

Decline and Threats:

Most populations are small and are threatened by agriculture, water diversions, and erosion.

***Arundo* impacts:** *Arundo* exacerbates many of these processes including: erosion, flooding, and modification of habitat to reduce flooding.

Status/Distribution or Historic and Current Range:

Endemic to California, the delta tule pea is found mainly in the Sacrament San Joaquin Delta and has been documented in Contra Costa, Sacramento, San Joaquin, Solano, Napa, and Alameda Counties.

***Arundo* overlap scores:** *Arundo* and delta tule pea both occur in the Delta region, overlapping with *Arundo* on 4 of the 25 watershed units (Table 6-5). Overlap scores between *Arundo* and delta tule pea range from moderate to high (3 to 7).

Sources:

CNPS Inventory of Rare and Endangered Plants http://www.rareplants.cnps.org/detail/956.html

https://www.natomasbasin.org/education/the-nbhcp-species/plants/delta-tule-pea/

Hart, J., J. Hunter. 2004. Restoring slough and riverbanks with biotechnical methods in the Sacramento-San Joaquin Delta. Ecological Restoration 22:262-268.

Suisun Marsh aster (*Symphyotrichum lentum*)

Federal status: None

State status: None

CRPR status: 1B.2

Arundo impact score: 6/10 (Moderate impact)

Moderate alteration of abiotic structure and/or biological function (impacts on general ecological needs, reproduction, diet, or movement).

General Ecological Needs/Habitat Affinities:

Suisun marsh aster is a perennial rhizomatous herb found in marshes and swamps, both brackish and freshwater. It is found <300m in elevation.

***Arundo* impacts:** *Arundo* does not usually grow in standing water in brackish marsh and slough habitat, it does occur along marsh/slough edges. These marsh/slough edge *Arundo* stands can drape over the marsh/slough, reducing the amount of marsh edge habitat that can be occupied by the Suisun marsh aster. This is often a narrow band of habitat, as water becomes too deep for plants to establish in the wetter portions of the marsh.

Breeding/Life History:

It blooms from May to November. It is a perennial herb with long rhizomes.

***Arundo* impacts:** *Arundo* stands directly compete/displace habitat areas where Suison marsh aster seedlings and rhizome fragments could establish. *Arundo* debris after flooding could also cover open substrate. Flow events depositing Suisun marsh aster rhizome fragments could have other flood debris, including *Arundo* biomass deposited on substrate.

Decline and Threats:

It is seriously threatened by marsh habitat alteration and loss, and also erosion.

***Arundo* impacts:** *Arundo* exacerbates many of these processes including: erosion, flooding, and modification of habitat to reduce flooding.

Status/Distribution or Historic and Current Range:

The Suisun marsh aster is currently found in Suisun marsh within the counties of Contra Costa Napa, Sacramento, San Joaquin, Solano, and Yolo.

***Arundo* overlap scores:** *Arundo* and Suison marsh aster both occur in the Delta region, overlapping with *Arundo* on 4 of the 25 watershed units (Table 6-5). Overlap scores between *Arundo* and Suison marsh aster range from moderate to high (4 to 7).

Sources:

CNPS Inventory of Rare and Endangered Plants http://www.rareplants.cnps.org/detail/289.html

Calflora https://www.calflora.org/cgi-bin/species_query.cgi?where-taxon=Symphyotrichum+lentum

Geraldine A. Allen 2012, *Symphyotrichum lentum*, in Jepson Flora Project (eds.) *Jepson eFlora*, http://ucjeps.berkeley.edu/eflora/eflora_display.php?tid=80304, accessed on October 21, 2019.

Woolly rose-mallow (*Hibiscus lasiocarpos* var. *occidentalis*)

Federal status: None

State status: None

CRPR status: 1B.2

Arundo impact score: 6/10 (Moderate impact)

Moderate alteration of abiotic structure and/or biological function (impacts on general ecological needs, reproduction, diet, or movement).

General Ecological Needs/Habitat Affinities:

Woolly rose-mallow is a perennial rhizomatous herb, subshrub from caudex, generally hairy. There are many stems from the base and it can be prostrate to erect to a height of 1-2m. It is an emergent plant that is often found in riprap on sides of levees. It is found in freshwater wetlands, wet banks, and marshes at elevations < 100 m.

***Arundo* impacts:** *Arundo* frequently grows in the same habitat areas, edges of marshes and levee banks, including rip rap. *Arundo* also overhangs marsh areas from adjacent elevated banks. In these situations *Arundo* has the potential to displace wooly rose mallow, or occupy habitat that woolly rose mallow could occupy. *Arundo* debris, deposited during flow events, can also degrade marsh habitat and the toe of the levee/bank.

Breeding/Life History:

Woolly rose-mallow generally blooms from June/July to November.

***Arundo* impacts:** *Arundo* debris and stands can interfere with wooly rose mallow seedling or rhizome establishment by occupying these spaces.

Decline and Threats:

Most occurrences are very small populations. It is seriously threatened by habitat disturbance, development, agriculture, recreational activities, and channelization of the Sacramento River and its tributaries. It is also threatened by weed control measures and erosion.

***Arundo* impacts:** *Arundo* colonization of riprap levees not uncommon, reducing habitat availability for rose-mallow. *Arundo* control programs should check treatment areas before work to assure that rose-mallow plants are not impacted when work is in suitable habitat.

Status/Distribution or Historic and Current Range:

It is currently found in the counties of: Butte, Contra Costa, Colusa, Glenn, Sacramento, San Joaquin, Solano, Sutter, and Yolo.

***Arundo* overlap scores:** *Arundo* and woolly rose-mallow both occur in the Delta and Sacramento Valley regions, overlapping with *Arundo* on 8 of the 25 watershed units (Table 6-5). Overlap scores between *Arundo* and woolly rose-mallow range from moderate to high (2 to 6).

Sources:

CNPS Inventory of Rare and Endangered Plants http://www.rareplants.cnps.org/detail/906.html

Calflora https://www.calflora.org/cgi-bin/species_query.cgi?where-taxon=Hibiscus+lasiocarpos+var.+occidentalis

Hill, S.R. 2012. *Hibiscus lasiocarpos var. occidentalis*, in Jepson Flora Project (eds.) *Jepson eFlora*, http://ucjeps.berkeley.edu/eflora/eflora_display.php?tid=91751, accessed on October 21, 2019.

Sanford's arrowhead (*Sagittaria sanfordii*)

Federal status: None

State status: None

CRPR status: 1B.2

Arundo impact score: 2/10 (Very low impact)

Potential alteration of biological function (impacts on general ecological needs, reproduction, diet, or movement).

General Ecological Needs/Habitat Affinities:

Sanford's arrowhead is a perennial rhizomatous herb. It is found in marshes, swamps, ponds and ditches (assorted shallow freshwater) at an elevation <300m. It has spherical tubers and emergent leaves with petioles that are more or less flat. It grows in standing or slow-moving freshwater ponds, marshes, and ditches in association with the water plantain (*Alisma plantago-aquatica*), water primrose (*Ludwigia peploides*), and various species of cattail (*Typha* spp.).

***Arundo* impacts:** *Arundo* does not grow in standing water in marsh and pond habitats. So there is very little direct habitat overlap of the two species. Arrowhead does not typically occur in the edges of the marsh/pond habitat, so there is much less impact from *Arundo* growing on levees and banks where it can overhang or collect on potential habitat.

Breeding/Life History:

Sanford's arrowhead blooms from May to October.

***Arundo* impacts:** Little impact as *Arundo* is not occupying suitable habitat, and *Arundo* debris is also unlikely to accumulate, as arrowhead habitat has very low energy flows.

Decline and Threats:

It is threatened by grazing, development, recreational activities, non-native plants, road widening, and channel alteration and maintenance.

***Arundo* impacts:** Few additional impacts.

Status/Distribution or Historic and Current Range:

This species is endemic to California, but it has mostly disappeared from the Central Valley and is no longer present in southern California. Several occurrences remain in Sacramento County along the American River Parkway, and records exist for Butte, Del Norte, El Dorado, Fresno, Merced, Mariposa, Orange, Placer, Shasta, San Joaquin, Tehama, and Ventura Counties.

***Arundo* overlap scores:** *Arundo* and Sanford's arrowhead both occur in the Delta and Sacramento Valley regions, overlapping with *Arundo* on 3 of the 25 watershed units (Table 6-5). Overlap scores between *Arundo* and Sanford's arrowhead range from low to moderate (1 to 5).

Sources:

CNPS Inventory of Rare and Endangered Plants, http://www.rareplants.cnps.org/detail/710.html

Charles E. Turner, Robert R. Haynes & C. Barre Hellquist 2012, *Sagittaria sanfordii*, in Jepson Flora Project (eds.) *Jepson eFlora*, http://ucjeps.berkeley.edu/eflora/eflora_display.php?tid=42633, accessed on October 21, 2019.

https://www.natomasbasin.org/education/the-nbhcp-species/plants/sanfords-arrowhead/

Scores: Program lead experience/capacity: 4 (out of 5).
Permitting capacity: 3 (out of 5).
Overall capacity: 7 (out of 10)

Tulare Lake-Los Gatos Creek (8 acres of *Arundo*)

This watershed unit falls within the jurisdiction of the Westside RCD which is not active.

Scores: Program lead experience/capacity: 0 (out of 5).
Permitting capacity: 0 (out of 5).
Overall capacity: 0 (out of 10)

Kings River (91 acres of *Arundo*)

This watershed unit falls within the jurisdiction of the Sierra RCD in eastern Fresno County. In addition, the Kings River Conservancy is enthusiastic about working to remove weeds and finding funding to do so. They work from Hwy 99 near Reedley north to the Pine Flat Dam to remove *Arundo*, tree-of-heaven, yellow starthistle and water hyacinth. They have a CEQA NOE. Cal-IPC provided information about where to see all of the mapped *Arundo* (in Calflora), how to design an *Arundo* removal program, how to contact the Sierra RCD and potential funding ideas.

Scores: Program lead experience/capacity: 2 (out of 5).
Permitting capacity: 2 (out of 5).
Overall capacity: 4 (out of 10)

Kaweah-Tule River (34 acres of *Arundo*)

This watershed unit falls within the jurisdiction of the Tulare RCD, which does have a small staff.

Scores: Program lead experience/capacity: 0 (out of 5).
Permitting capacity: 0 (out of 5).
Overall capacity: 0 (out of 10)

Kern River (4 acres of *Arundo*)

This watershed unit falls within the jurisdiction of the North West Kern RCD which does not seem to be active.

Scores: Program lead experience/capacity: 0 (out of 5).
Permitting capacity: 0 (out of 5).
Overall capacity: 0 (out of 10)