APPENDIX I: SITE ASSESSMENT PROTOCOL AND EXAMPLE

The following pages provide the protocol that was used for conducting site assessments for nonnative fish eradication areas proposed in the Sequoia and Kings Canyon National Parks Restoration of Native Species in High Elevation Aquatic Ecosystem Plan / Final Environmental Impact Statement (Restoration Plan/FEIS), and a sample site assessment.

Between 2008 and 2015, full site assessments and reports were completed for all 21 proposed fish eradication basins in the Restoration Plan/FEIS. In totality, these site assessment reports comprise over 200 pages of information. As all of these site assessment reports contain the same type of information and format, it would be redundant to include all of them in this document. Therefore, one site assessment report is included as an example of the type and detail of information that has been collected and assessed for each proposed fish eradication site. In addition, site assessment reports contain sensitive and/or protected locality information for special-status species. Specific locality information regarding special-status species has been redacted from the site assessment report included in this appendix.

Site assessments were undertaken by field crews to determine the feasibility of restoring high elevation lakes and streams to their natural fishless state. The components of a site assessment include: assessing fish distribution; quantifying and marking strategic barriers; surveying for MYLF distribution; providing input for the restoration techniques exclusive to the site; assessing accessibility and safety; finding a low-impact, long-term base camps; and, establishing a safe helicopter landing zone or stock drop-point.

Proposed restoration sites were thoroughly evaluated prior to including in the preferred alternative. One to two employees visited each site and collected detailed information to formulate strategies that consider all aspects of the area. Some of the pertinent information was quantified; qualitative observations were also relied upon. Along with additional resources (e.g., data from cooperators and local knowledge), the results of site assessments will be used to formulate prescriptions for future restoration work.

Two site assessment factors of concern were received in public comments for the Restoration Plan/DEIS (NPS 2013A): (1) determining feasibility of complete fish eradication using the proposed methods, and (2) ensuring that stream barriers are definitively not passable by fish. SEKI personnel have over two decades of combined experience in removing fish using physical methods. Therefore, there is confidence in the on-site assessments regarding the feasibility of fish removal where physical methods are proposed. Sites in which piscicide application has been proposed would receive additional scrutiny from both SEKI staff and individuals experienced in piscicide treatments. Before the initiation of any new fish eradication work, all barriers at approved sites would be reassessed to ensure there is consensus that the selected barrier is impassable by fish.

Mountain Yellow-legged Frog Restoration Project: Site Assessment Protocol
Sequoia and Kings Canyon National Parks

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Introduction/Overview

Site assessments will be conducted by field crews to evaluate the feasibility of restoring high elevation lakes and streams to their natural fishless state. The components of a site assessment include: assessing fish distribution, quantifying and marking strategic barriers, surveying for mountain yellow-legged frog distribution, providing input for the restoration techniques exclusive to the site, assessing access and safety, finding a site appropriate for a low impact long-term base camp, and establishing a safe helicopter landing zone and/or a drop-off point for stock.

Proposed restoration sites need to be thoroughly evaluated prior to including in the restoration plan. For each site, one to two employees will visit the site and collect detailed information and formulate strategies that consider all aspects of the area. Some of the pertinent information will be quantified, but qualitative observations are also used. Along with additional resources (e.g., Knapp lake project, local knowledge), the results of these site assessments will inform prescriptions for future restoration work.

All field data are recorded into standardized data sheets (attached). Before each site visit, crews will be equipped with several relevant GIS-generated maps. All lakes will be referred to in their five digit "Knapp Lake ID." All references to lakes use these unique IDs. Additionally, maps will be used for drawing unique features that do not show up on standard maps (e.g., braids, wetlands, cliffs, etc.) or cannot be fully explained on the data sheets.

The following is the information, definitions, and instructions for the site assessments, and the standardized data sheets.

Restoration Lakes
Prior to the site visit, potential restoration lakes would be identified. It is necessary to meticulously assess each of these lakes so we can fully understand lake-specific issues.

Lake ID: Record the five digit Knapp ID of the waterbody being assessed. Lake IDs are shown on field maps.

Fish Species: Record the four letter abbreviation of the fish species present at the waterbody being assessed. Record ONSP for rainbow x golden trout hybrids (*Oncorhynchus spp.*); ONMY for rainbow trout (*Oncorhynchus mykiss)*; SAFO for brook trout (*Salvelinus fontinalis*); UNKN for unknown identification.

YOY: Record Yes or No for presence of young of the year (larval) trout.

Spawning Habitat: Record Yes or No if lentic fish spawning habitat exists. If yes, attempt to quantify area in m^2.

Density: Record visual fish densities as Low, Medium or High. This category is subjective. If you only detect adult fish of similar sizes, record as Low. If all life stages are present, well represented and abundant, record as High. Fish densities in between these perimeters can be recorded as Medium.

Estimated Nets: Estimate the number of nets that are necessary to reach eradication. Our typical formula for effective coverage is 1 net per 40 m of shoreline. State whether nets should be added or reduced based on this formula.

Comments: Provide a detailed analysis of the lake. Include all unique features, including feasibility, potential pitfalls, etc. Refer to the site map when necessary. Include photograph numbers of all pictures of the lake.

Barrier Assessment
Streams are incredibly important to investigate thoroughly during site assessments, specifically in terms of habitat complexity, fish distributions, basic hydrology, and presence/absence of barriers. Determining whether barriers to fish movement are present along stream channels in proposed restoration areas is critical to the success of fish removal efforts. Fish can regain access to restoration sites if definitive downstream barriers are not present. If a feature thought to be a barrier is actually surmountable by fish, all restoration work would be compromised.

Features that may act as a barrier depend on the habitat specific to a site. Small order streams may not require large barriers to actually prevent fish passage. However, in terms of smaller features, there is no set rule on what may actually be a fish barrier in all circumstances. Certain habitat features may look like barriers, but their effectiveness in preventing upstream fish movement is indeterminate. Such features may include small drops, low gradient sections of sheet flow over bedrock, or rock piles.

In proposed restoration areas, experienced fisheries biologists should assess a proposed barrier to make an initial determination on whether the feature actually constitutes a barrier to fish passage. Some features are clearly complete barriers (e.g., tall, vertical waterfalls around which water cannot skirt during high flows). However, in most instances, determining whether a proposed barrier blocks fish passage during any flow condition is very difficult. In these cases, additional assessment would likely be necessary.

Two possible methods to further investigate the effectiveness of a barrier include, 1) setting up a trail camera to monitor the barrier under different flow conditions and 2) capturing 100 (or more) trout downstream of the proposed barrier and then monitoring the area upstream with angling, electrofishing, and/or gill netting to see if any marked fish are present above the barrier over the next couple of years. Clearly, these additional monitoring methods would involve substantial time and effort. Additionally, marking trout and monitoring for their presence above a barrier would need to begin at least two years prior to starting any proposed upstream fish eradication at the site in question. However, the additional endeavor would be well worth pursing, since careful monitoring would help ensure that eradication efforts would not be compromised by fish returning to the restoration area.

Features that can be definitively determined as conclusive barriers through visual inspection alone are uncommon. However, they mainly include:

- **Vertical waterfalls** (≥3 m high; Figures 1a-1c). This feature is the easiest to confirm as definitively insurmountable. Trout in most parts of the high Sierra Nevada are <20 cm (NPS 2015) and cannot negotiate vertical features more than 1–2 m high. Plunge pools present beneath the barrier face provide more ability for trout to leap over smaller drops. However, if a vertical barrier is more than several meters high, trout would not be able to leap upstream.

The following features–***if found along a steep gradient***–may be impassible by fish:

- **Sheet flow over bedrock** (Figure 2). These features are more subjective, but stream reaches with long sections of very steep gradient flowing over smooth bedrock may not be surmountable by fish.
- **Piles of dense talus** (Figures 3a and 3b). Many streams in the Sierra Nevada contain talus slopes through which streams flow. If the talus is loosely piled, fish may be able to access areas upstream. However, in many cases, talus is densely piled on steep slopes, and water may only percolate through rock interstices. If the talus pile is large and well-consolidated, fish would not be able to pass through.
- **Slot channels through bedrock** (Figures 4a and 4b). High angle slots carved into bedrock can prevent all upstream fish movement.
- **Long sections of stream with multiple drops** (Figures 5a and 5b). Even if no individual drop seems unquestionably insurmountable by fish, many high elevation streams in the Sierra Nevada flow at steep angles over long sections (e.g., tens to hundreds of meters) with multiple 1-2 meter drops and rock piles. Many of these very steep reaches can prevent upstream fish movement.

Restoration Streams
Prior to the site visit, potential restoration streams would be identified. Each section would be labeled by a unique letter (i.e. A, B, C, etc.). Typically, sections would be labeled as follows: Section A includes Lake 12345 outlet stream to downstream fish barrier or Section B includes Lake 12345 inlet to first upstream confluence.

Section: Unique stream section label provided on field maps. Stream sections would be labeled as A, B, C, etc.

Fish Species: Record the 4 letter abbreviation of the fish species present at the waterbody being assessed. Record ONSP for rainbow x golden trout hybrids (*Oncorhynchus spp.*); ONMY for rainbow trout (*Oncorhynchus mykiss);* SAFO for eastern brook trout (*Salvelinus fontinalis*) UNKN for unknown identification.

YOY: Record Yes or No for presence of young of the year (larval) trout.

Spawning Habitat: Record if lotic spawning habitat exists. If yes, attempt to quantify area in m^2.

Upstream Barrier: If the recorded stream section would be used as a barrier or this stream section ends at the furthest upstream fish distribution, provide the UTM coordinates in datum NAD 83. Upstream fish distribution is important to quantify because it allows us to estimate the amount of potential stream habitat to be restored.

Downstream Barrier: If the recorded stream section would be used as a barrier to fish recolonization into the restoration area, provide the UTM coordinates in datum NAD 83. Downstream fish distribution is important to quantify because it allows us to estimate the amount of potential stream habitat to be restored.

Comments: Provide a detailed analysis of the stream. Include all unique features, including feasibility, potential pitfalls, and restoration technique (i.e., physical or piscicides). Refer to the site map when necessary. Include photograph numbers of all pictures of the stream. If a barrier is marked, take a picture and provide the picture number.

Amphibian Surveys

We would be conducting amphibian surveys at select lakes in the proposed site to assess pre restoration frog distribution. The crew should attempt to officially (protocol) or opportunistically (quick searches) survey each lake that is to be restored. If conducting an official survey, follow the amphibian monitoring protocol below for required fields. If opportunistic amphibian observations were recorded, include this information in the Frog Surveys section of the data sheet.

Lake ID: Record the 5 digit Knapp ID of the waterbody being surveyed. Lake ID's are shown on field maps.

Air temperature and time: Just before you begin surveying AND right after you end surveying, measure the air temperature at the lake shore at 1 m above the lake surface. Record each temperature in Celsius.

Water temperature and time: Just before you begin surveying AND right after you end surveying, measure the water temperature approximately 0.5 m out from shore and 10 cm under the water surface. Record each temperature in Celsius.

Weather and Wind: Just before you begin surveying AND right after you end surveying, define cloud cover as clear (0-4 % cloud cover), partly cloudy (5-49 % cloud cover), mostly cloudy (50-95%), overcast (96-100 %), rain or snow. Define wind as none, light (0-4 mph; small ripples on water surface), moderate (5-10 mph; waves on water surface, but no whitecaps) or heavy (> 10 mph; whitecap waves on water surface).

Survey start time and end time: Record the times at which the survey began and ended. The start time is the time the amphibian survey began, not the time you arrived at the site. Record time as 24 hr time.

Total survey duration: Record the total time spent searching for amphibians. Do not include time spent surmounting lake-side obstacles (e.g., cliffs), identifying specimens, or recording notes. If two people survey the same site by walking in opposite directions around the lake perimeter, the total survey duration should include the time spent surveying by each person (e.g., record as 15 min + 18 min = 33 min).

Visual fish survey: During the amphibian survey, look carefully in the waterbody for fish swimming in water or rising on the surface. Record whether fish were detected or not detected.

Amphibian detections: To conduct a survey, walk **slowly** around the perimeter of the site, counting the number of adults, subadults, larvae, and egg masses you find of each amphibian and reptile species. Species abbreviations are:

RAMU (*Rana muscosa*, southern mountain yellow-legged frog); **BUCA** (*Bufo canorus*, Yosemite toad);
RASI (*Rana sierrae*, Sierra Nevada yellow-legged frog); **BUBO** (*Bufo boreas*, western toad);
PSRE (*Pseudacris regilla*, Pacific tree frog);
THEL (*Thamnophis elegans elegans*, mountain garter snake); **THCO** (*Thamnophis couchii*, Sierra garter snake)

Use the following description as a guide for identifying egg masses.

RAMU Laid in globular and often flattened clumps, 1-3 inches in diameter, attached to boulders; banks of ponds, lakes, and streams; or stems of vegetation; **individual eggs are solid black and 1-2 mm in diameter**.
HYRE Laid in loose, irregular clusters of 9-80 eggs (often 20-25), 0.5-1 inch in diameter, attached to plant stems, sticks, or other debris in shallow, quiet water of ponds, lake borders, and streams.
BUCA Laid in beadlike strings and clusters, often covered with silt, in the shallows of meadow pools. You can see indentations in the string between each egg.
BUBO Laid in tangled strings of 1-3 rows (typically 2), often entwined in vegetation along edges of ponds, lakes, and streams. Eggs are enclosed in a tube, so you cannot see indentations in the string between each egg.

Comments: Record any interesting observations made during the survey (e.g., tadpoles found only in shallow lagoon on NW side of lake; the sole RAMU adult detected was large – approx. 7.0 cm snout-vent length; several Brewer's blackbirds were feeding at different shoreline areas – likely predating on abundance of RAMU larvae at this site).

Operations
Many of the prospective restoration sites would be occupied by crews for several summer field seasons. A long term restoration camp requires a suitable camp location, permanent accessible drinking water and gear access via helicopter or stock. If there are multiple locations for each operation-related feature, include all and identify each in the order of suitability.

Feature: Identify all features relevant for restoration operations. These include, but are not limited to camp site, helicopter landing zone (LZ), stock drop-off location, human refuse (i.e. boomer) and drinking water collection.

UTM E: UTM easting of the feature location, in NAD 83.
UTM N: UTM northing of the feature location, in NAD 83.

Comments: Include all relevant comments regarding the feature location. Example: This camp location is within 150 meters from a permanent water source. It is located in a stand of pine trees to block up canyon wind and out of view from the hiking trail.

Site Comments
Use the site comments box to address any additional information that wasn't covered in the previous sections. Also, use this area to continue comments that exceed the allowed space in the previous sections.

Please be specific and always refer to the 5 digit Lake IDs and stream section letters when referring to restoration areas.

This section should be used to discuss all safety hazards at the site. Additionally, describe in detail the hiking route to the site. Often, these areas require considerable off-trail hiking. It is necessary to document the safest and most effective route to each site. In addition to this description, please trace the route on the site map.

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Figure 1a. Vertical rock face barrier.

Figure 1b. Another example of a tall, high gradient waterfall barrier at low flow.

Figure 1c. Large waterfall barrier. Although the entire waterfall is not vertical, this waterfall contains an initial 3 meter vertical drop, followed by a steep cascade. (Note: without a person in this image, the perspective is difficult to judge, but this is waterfall is very tall [~7 m high] and steep.)

Figure 2. Example of sheet flow. This particular feature may not be a definitive barrier at high flows. However, if this type of feature is at a high gradient and flows over several meters, fish are not able to move upstream.

Figure 3a. Dense talus barrier between two lakes. Large, dense talus piles like this one are definitive fish barriers.

Figure 3b. There is actually a stream flowing underneath this talus slope. However, densely conglomerated talus through which a stream percolates prevents any upstream fish movement.

Figure 4a. A steep "slot canyon" barrier flowing through bedrock.

Figure 4b. A small (~3 m) slot barrier through bedrock. This slot barrier also contains lodged boulders that act as a shelf, which provides additional assurance that upstream fish movement is completely restricted.

Figure 5a. A long stretch of outlet stream at the lower end of a basin. Although there are no vertical drops larger than 1 or 2 meters in this section, the combination of many smaller vertical faces, steep gradients, and rock piles would prevent upstream fish movement.

Figure 5b. High angle slot canyon barrier full of large talus. This particular barrier is not vertical in most areas, but it is very steep and contains several small vertical sections. The combination of steep gradient, rock piles, and drops prevent any upstream fish movement.

Restoration Lakes

Lake ID	Fish Spp.	YOY?	Spawn Hab.	Density	Est. Nets	Comments (Restoration technique, unique features, complexity, issues, etc.)

Lake ID: *5 digit Knapp code*; **Fish spp.:** *ONSP, ONMY, SAFO, UNKN;* **YOY?:** *young of year present, Yes or No;* **Spawn Hab.:** *Presence and estimated area of lentic spawning habitat;* **Density:** *density of fish, low, medium or high;* **Est. Nets:** *estimate # of nets to eradicate fish;* **Comments:** *detailed analysis of the features of the lake, photo #'s*

Restoration Streams

Section	Fish Spp.	YOY?	Spawn Hab.	Upstream Barrier	Downstream Barrier	Comments (Restoration technique, unique features, complexity, issues, etc.)
				E: N:	E: N:	
				E: N:	E: N:	
				E: N:	E: N:	
				E: N:	E: N:	
				E: N:	E: N:	

Section: *Ex. A, B, C, etc. as labeled on site map;* **Fish spp.:** *ONSP, ONMY, SAFO, UNKN;* **YOY?:** *young of year present, Yes or No;* **Spawn Hab.:** *Presence and estimated area of lotic spawning habitat;* **Upstream Barrier:** *UTM of furthest upstream fish distribution;* **Downstream Barrier:** *UTM of definitive downstream fish barrier;* **Comments:** *detailed analysis of the features of this stream section, including its connectivity to the restoration lakes*

Frog Surveys

Lake ID	Start				End				Start Time	End Time	Total	Spp.	Life Stage					Fish?	Comments:
	Air	H_20	Weather	Wind	Air	H_20	Weather	Wind					A	SA	LL	ML	SL		

Lake ID: *5 digit Knapp code*; **Temperature:** *Air and H_20 in Celsius;* **Weather:** *Clear, partly cloudy, mostly cloudy, overcast, rain or snow;* **Wind:** *none, light, moderate or heavy;* **Start and End Time:** *24 hour time;* **Total:** *total survey duration;* **Spp.:** *species encountered, RAMU, RASI, PSRE, BUCA, BUBO, THEL, THCO;* **Life Stage:** *A=adult, SA=subadult, LL=large larvae, ML=medium larvae, SL=small larvae;* **Fish ?:** *presence, Yes or No;* **Comments:** *general observations during the survey, photo #'s*

Operations

Feature	UTM E	UTM N	Comments

Feature: *Camp, LZ, spring, etc.;* **UTM E:** *Easting;* **UTM N:** *Northing;* **Comments:** *detailed description of the feature, photo #'s*

Site Comments

Enter all additional relevant information unique to this restoration site in the above area. Please be specific.

Mountain Yellow-legged Frog Restoration Project: UPPER EVOLUTION SITE ASSESSMENT
Sequoia and Kings Canyon National Parks
November 22, 2013

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Introduction

This report combines field work conducted during summers 2010 and 2012, the combined efforts of which create a complete site assessment for the proposed Upper Evolution basin restoration area (Map 1). On August 8th, 2010 and August 17-18, 2012, we conducted a site assessment of Upper Evolution basin to evaluate the feasibility of restoring six water bodies and adjacent inlet and outlet streams to their natural fishless state. In 2010, only three lakes were assessed because a lightning storm occurred during the visit. However, a full assessment was completed during the subsequent visit in 2012. We used the five digit lake ID's from the Knapp lake assessment project for nomenclature (Map 2). Our goals for site assessments include: assess fish distribution; quantify and mark strategic fish barriers; survey for mountain yellow-legged frog (MYLF) distribution; provide input for the restoration techniques exclusive to the site; assess accessibility and safety; find a low impact, long-term base camp; and establish a safe helicopter landing zone. The following text outlines the results of the Upper Evolution site assessment.

Proposed Site

The Upper Evolution site is located in the headwaters of the South Fork San Joaquin River (Map 1). This site is located in Evolution Basin, just north of Muir Pass and South of Evolution Valley. Proposed restoration work would occur from 3390 to 3535 m elevation. There are four fish containing lakes, one pond, and approximately 2.7 km of fish-containing stream habitat. This number may be misleading, however, because there are some braided sections of stream excluded from the GIS stream layer used to calculate distances. The stream distances also do not take into account drying habitat, which could greatly reduce the stream length that is treated. Most of the currently fishless habitat in Upper Evolution is either high in the basin, or composed of small, shallow ponds surrounded by large, fish-containing water bodies (Map 2).

Proposed Methods

To restore the Upper Evolution site, we would employ a combined "physical" fish-removal techniques with chemical treatment in a subset of stream sections (Map 2). This includes using methods of fish removal such as gill netting and electrofishing in the lakes, ponds, and several stream sections. The remaining fish-containing stream sections for which physical methods are not feasible would be treated using a chemical piscicide.

Proposed Lakes

Fish Removal-Lakes 10091, 11870, 10090, 10069, and 10511, plus adjacent streams and marsh habitat

Lake 10091 (Lake McDermand) is 21.4 acres with a shoreline perimeter of 1328 m, a max depth of 8.0 m and an elevation of 3520 m (Table 1; Map 2). This lake contains a moderately dense population of rainbow X golden trout hybrids (*Oncorhynchus* spp.). The trout population is self-sustaining, with abundant spawning habitat around the shallow littoral zone of the lake. All inlets either dry up or contain a very small amount of water. Barriers are denoted on the prescription map (Map 2), but no fish were observed occupying these stream segments during the site assessment. The main inlets are shallow, braided, and enter into a meadow area before they reach the lake. At this interface, there is ample

spawning habitat, with several redds observed. The southern part of the lake consists of a shallow shelf. Fish were not observed frequently here. They were observed in higher densities in the deeper, northern part of the lake (Map 2). The outlet stream travels 30 m downstream until it reaches Lake 11870.

Lake 11870 is 0.5 acres with a shoreline perimeter of 261 m, a max depth of 1.5 m, and an elevation of 3520 m (Table 1; Map 2). This lake contains a low density population of rainbow X golden trout hybrids. The stream connecting this lake and Lake 10091 is low gradient, primarily lentic habitat with nothing restricting fish travel between lakes. The outlet stream travels 70 m before it gets to an area of talus subsurface flow (Map 2). Trout were not observed from Lake 11870 to this barrier, however, trout were observed at low densities below this barrier. It was noted that the subsurface talus area probably blocked fish travel upstream. Below the barrier, the stream travels 275 m of low gradient, shallow flow until it reaches Lake 10090.

Lake 10090 (Wanda Lake) is 173.9 acres with a shoreline perimeter of 7498 m, a max depth of 30 m, and an elevation of 3483 m (Table 1; Map 2). The inlet stream is described above. This lake contains extremely low densities of rainbow X golden trout hybrids. Although very large, Lake 10090 does not appear to have a reproducing fish population. It should be noted that we believe trout are not traveling from Lake 10090 to upstream waters. Rather, we think fish are occasionally traveling downstream during high flow events. Gill nets set during the initial survey visit for the lake assessment project in 1997 resulted in zero captures. Subsequent visual surveys by NPS staff and researchers have only observed a few fish during 3 out of 12 surveys. The last year any fish were seen in this lake was 2010, during which time only a few trout were observed near the inlet. Occasional trout have also been observed in the inlet, below the talus barrier. However, no fish were observed during visual surveys of the entire lake perimeter in August 2012.

The outlet stream of Lake 10090 is low gradient, braided, and flows over a homogenous cobble substrate. The outlet is 1.2 km long and contains two channels beginning at the margin of Lake 10090. The two braids join several hundred meters downstream prior to entering Lake 10069. The two stream segments, from the edge of Lake 10090 to where they rejoin, are fairly uniform: there is one primary channel flowing over rocky substrate of various sizes. Both segments contain several small barriers, each of which alone likely block fish passage during most of the year. The combination of relatively steep gradient and numerous smaller barriers in each channel likely block fish completely.

Approximately 250 m prior to entering Lake 10069, the stream bed widens into a complex, low gradient assemblage of dense boulders and cobble (Photos 1 and 2). Electrofishing efforts would be incredibly difficult, if not impossible, in this stream segment (Map 2, in yellow). Electrofishing would be more feasible in the upper section of the Lake 10090 outlet, where the stream diverges into two braids (Map 2, in purple). No fish were observed in any portion of this stream segment (including both channels) during surveys on August 18, 2012. However, it was a dry summer and flows were very low. For example, in the wide, shallow stream section upstream of Lake 10069 (Photo 2), most water was flowing subsurface, so fish would be unlikely to swim upstream from Lake 10069. Despite these considerations, given the fact that there is no single large, definitive barrier present along the stream segment between Lakes 10069 and 10090, we cannot definitively rule out the possibility of fish passage.

Lake 10069 is 28.5 acres with a shoreline perimeter of 2136 m, a max depth of 12.0 m, and an elevation of 3443 m (Table 1; Map 2). This lake contains low to moderate densities of rainbow X golden trout hybrids. A majority of fish observed were large (upper 10-20, lower 20-30 cm size classes). The trout population is self-sustaining, with spawning habitat available along many areas of the shallow littoral zone of the lake. The inlet stream is described above. The 80 m, low gradient outlet stream contains no barriers and a heterogeneous mix of boulder and cobble (Photo 3). Several trout were observed in the outlet stream during surveys.

The complex network of marshy stream habitat due west of Lake 10069 would be logistically difficulty if physical methods were attempted (Photo 4). The stream network is far too shallow, complex, and full of dense rocky substrate for electrofishing. Therefore, we are proposing the use of piscicides, which could greatly ease efforts to remove fish in this area. Although the habitat appears poor for trout, we observed trout in a few small, isolated pools. Given that we observed trout in cut off pools when this area was almost completely dry, it is likely that trout use this stream network more extensively earlier in the season. The stream network probably dries completely by late September during most years.

There is a very small pond south of Lake 10511 into which a secondary channel of the inlet to Lake 10069 flows (Photo 5). This pond and associated marshy habitat contain moderate densities of rainbow X golden trout hybrids. Although it is likely trout could be easily removed from the pond using a combination of gill net fragments and electrofishing, we are proposing piscicide use for removing fish in this area. We chose piscicides because this small pond is directly connected to the wide, complex section of the inlet to Lake 10069 (Photos 1 and 2), and in close proximity to the complex stream network described above (Photo 4).

Lake 10511 is 4.4 acres with a shoreline perimeter of 898 m, a max depth of 8.0 m, and an elevation of 3442 m (Table 1; Map 2). This lake contains a moderate density of rainbow X golden trout hybrids. There were various size classes of fish, including YOY, +1, and adult trout. The trout population is self-sustaining, with abundant spawning habitat available along the shallow littoral zone of the lake. There is a small pond displayed on some topographic maps just north of the main lake. However, there is no pond at this location; west of the stream channel there is some marshy habitat, which mostly dries by late summer. The inlet stream is described above. The outlet stream flows for ~400 m before widening into a shallow, complex network of mixed cobble (Photo 6). Due to the complex habitat configuration, electrofishing would not be a feasible alternative in this stream section. The outlet stream splits into a few channels ~650 m downstream from Lake 10511, after which all channels descend down a steep waterfall barrier. This barrier is definitive, so all fish passage upstream from Sapphire Lake is completely blocked. Only a few trout were observed in the outlet stream.

Table 1. Lake descriptions for all proposed lakes in the Upper Evolution restoration site.

Lake ID	Area (ac)	Perimeter (m)	Max Depth (m)	Elevation (m)
10091	21.4	1328.0	8	3517
11870	0.5	261.1	1.5	3517
10090†	173.9	7498.1	30	3483
10069*	28.5	2136.3	12	3443
10511*	4.4	898.2	8	3442

†Lake 10090 was visited in both August 2010 and 2012.
* Lakes assessed during second site assessment trip in August 2012.

Complete eradication of trout can be achieved with a deployment of 35-40 gill nets in Lake 10091, and two nets in Lake 11870. It is unknown how many nets would be needed in Lake 10090. We would likely start by setting nets in the inlets, outlets, and select areas along the lake. Based on catch intensity, we would adjust net placement and abundance. 40-45 nets would be placed in Lake 10069 and 10 nets would be set in Lake 10511. In addition, there is a maximum of 1.9 km of electrofishing and 0.77 km of piscicide application if we chose to restore all proposed stream habitat. However, this is likely an overestimate, since many parts of the stream (especially where there are wide, shallow stretches of dense cobble) are not suitable for trout occupancy.

Frog Response
During the site assessment in 2010, a mountain yellow-legged frog survey was conducted at Lake 10091. No other official surveys were conducted in 2010 due to nearby thunderstorms.

In 2012, we conducted MYLF surveys at the remaining lakes in the proposed treatment area.

Additional Information

Accessibility
Crews would likely access this site from the North Lake Trailhead. Take the trail toward Lamarck Lakes, branching off the main trail to the south soon before reaching Upper Lamarck Lake. Follow the unmaintained trail to the south and west, over a ridgeline and up the valley northeast of Mt. Lamarck. The trail would lead up and over Lamarck Col. A detailed description of the route can be found in Secor (2009; Pg. 308). Descend down the faint trail along the scree slope south of Lamarck Col, heading southwest into Darwin Canyon. Approach the second lake to the west and follow along the northern shoreline of the Darwin Canyon lakes. Once out of Darwin Canyon, head south along a faint unmaintained trail, keeping just to the east of the small pond on Darwin Bench. The unmaintained trail heads southwest, just east of the Darwin Bench outlet stream. Descend the trail until reaching the Pacific Crest Trail (PCT). Once on the PCT, head southeast past Evolution Lakes and into Upper Evolution basin (Map 3).

If snow conditions make the route over Lamarck Col a safety hazard, entering from the South Lake trailhead provides an alternate route into Upper Evolution basin. After reaching Bishop Pass, the head down to LeConte Canyon, north to Muir Pass, and then down to Lake 10091. South of this lake, head counterclockwise off trail until you get to the camp area. An alternative camp area is located on the area of dry land between Lakes 10069 and 10511 (an additional 3 km; Map 2).

Base Camp
When looking for a base camp, we prioritize sites with granite slabs, decomposed granite substrate absent of vegetation, or previously impacted camps. These areas must be out of the colonization route mountain yellow-legged frogs take from the source pond to the restoration lakes. In considering visitor wilderness experience, we attempt to blend into the surrounding environment. This involves using trees for camouflage and staying away from developed trails. Our camp sites should be in close proximity to water for camp supply. We look for sites that provide efficient access to all restoration lakes.

The base camp for this site could be located on either the eastern shoreline of Lake 10091 or south of Lake 10511 (Map 2). Both areas are flat, with decomposed granite substrate, and sparse vegetation (i.e., no trees). The location adjacent to Lake 10091 is next to a spring that can be utilized for camp and drinking water purposes. It is out of view of the PCT. The only downside is that it is a very barren area, with potentially dangerous exposure to lightning. This entire basin is similarly exposed.

The other proposed camping area is also exposed and more visible from the PCT. However, it is very difficult to find a flat area with adequate camping for several people that is not at least partially in view of the trail, since the trail passes through the entire basin where most of the flat areas are located, and there are no trees. There were some small potential camping areas on the northwest side of Lake 10069, but we could not readily determine if they would be dry during a more typical year (2012 was one of the driest summers on record).

Landing Zone and Stock Support
There are several factors to consider when looking for a good landing zone. First, the general area should be void of trees and boulders that could pose a threat to helicopter rotors. Second, the landing zone should

be on a flat, level surface. Lastly, we look to minimize exposed areas that may leave the helicopter subject to heavy winds. To maximize safety and performance of the mobilization, we choose sites with in-ground effect. The landing zone chosen near Lake 10091 exhibits all of the above conditions (Map 2). The landing zone is also in close proximity to the chosen base camp. Stock support may not be feasible due to the remoteness and lack of grazing opportunities in this location.

There are two additional landing site options southwest of Lakes 10069 and 10511. Both sites meet the safety criteria listed in the description above. Additionally, both landing sites are close to the other proposed camping site between Lakes 10069 and 10511.

Safety Hazards
The following safety hazards exist at this site: gill netting, electrofishing, piscicide application, exposure to extreme weather, lightning, dehydration, hypothermia, heat-related illnesses, exhaustion, altitude sickness, and hiking related injuries.

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Photo 1. Wide, low gradient section of inlet just upstream of Lake 10069 (in background). Facing east.

Photo 2. Wide, low gradient section of inlet stream above Lake 10069. Facing southwest and upstream toward lake 10090.

Photo 3. Stream segment between Lakes 10069 and 10511. Facing east.

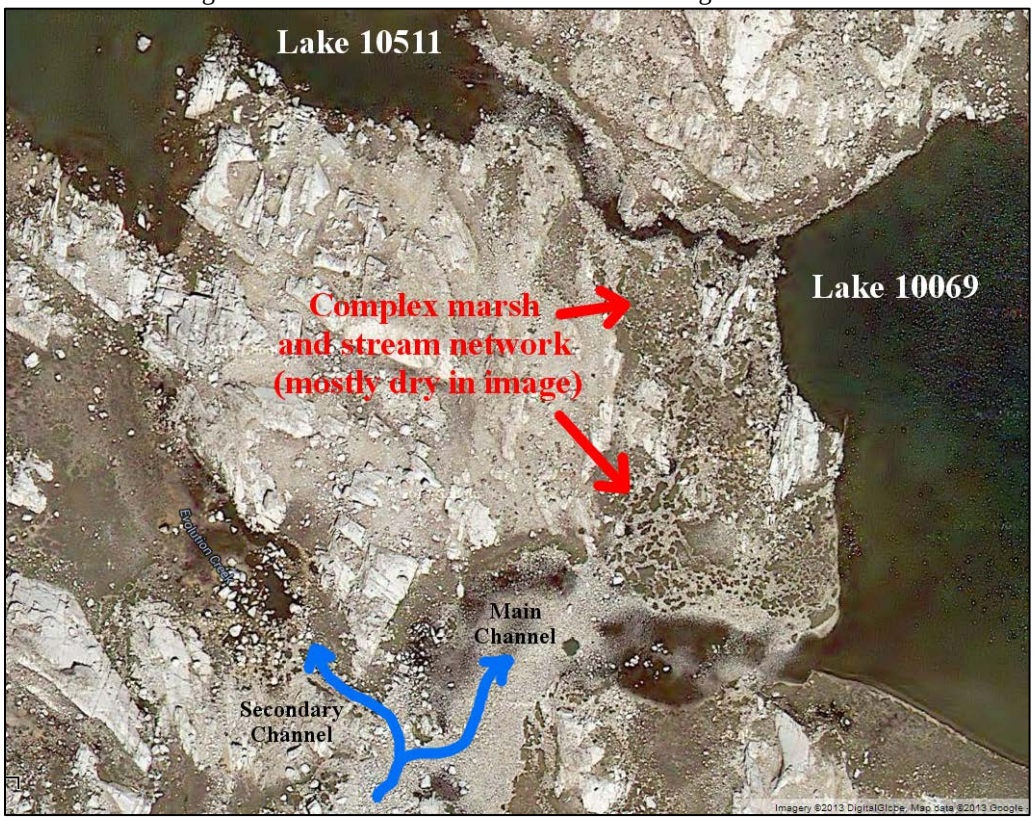
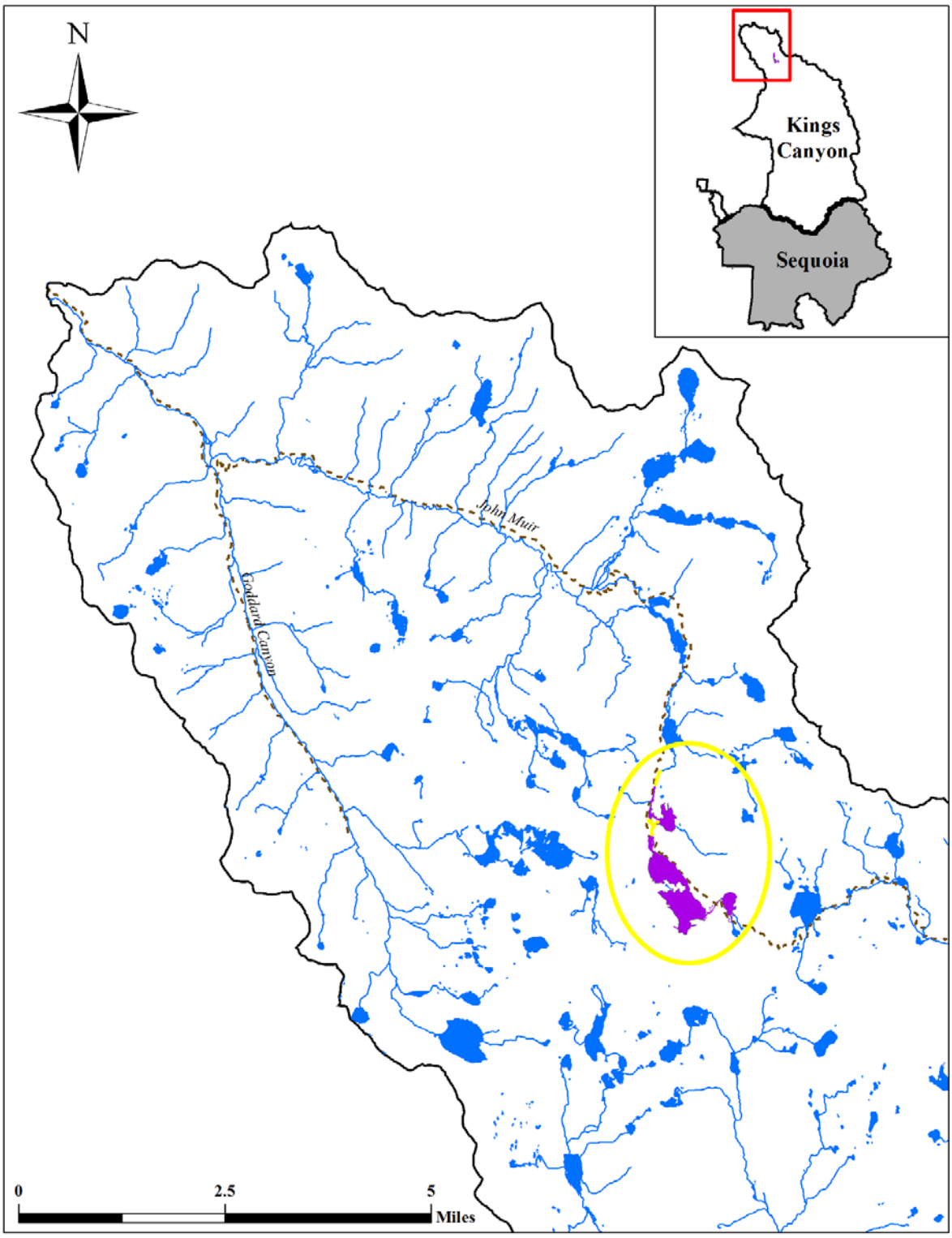


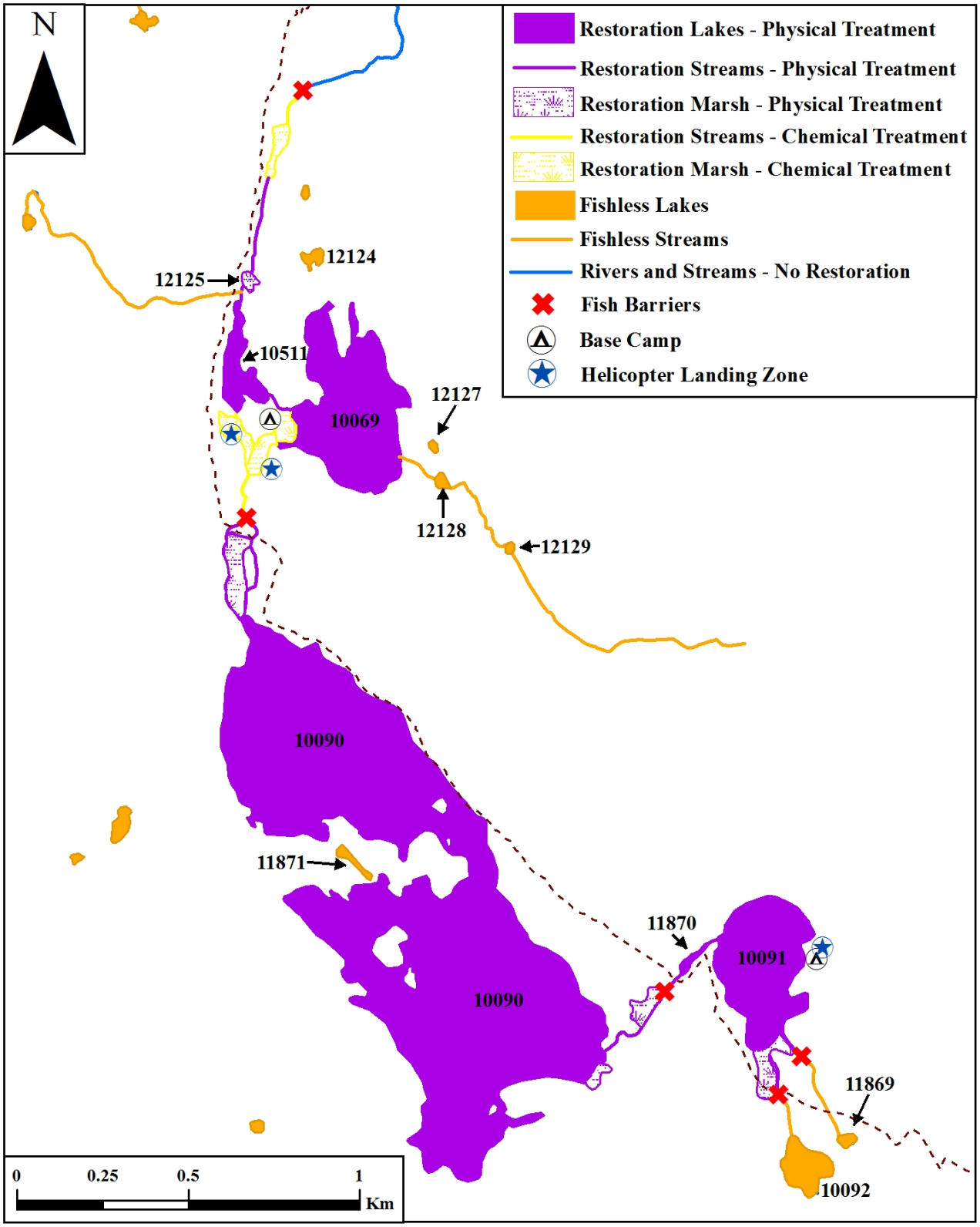
Photo 4. Aerial image showing the complex stream network west of Lake 10069. This area was mostly dry during the site visit in August 2012, but did contain isolated pools with fish. Also shown are the main and secondary channels of the inlet to Lake 10069, inlet to Lake 10511 (see also Photo 3), and small pond and marshy area south of Lake 10511 (see also Photo 5).

Photo 5. Small pond and marshy area south of Lake 10511 and west of Lake 10069. Facing south.

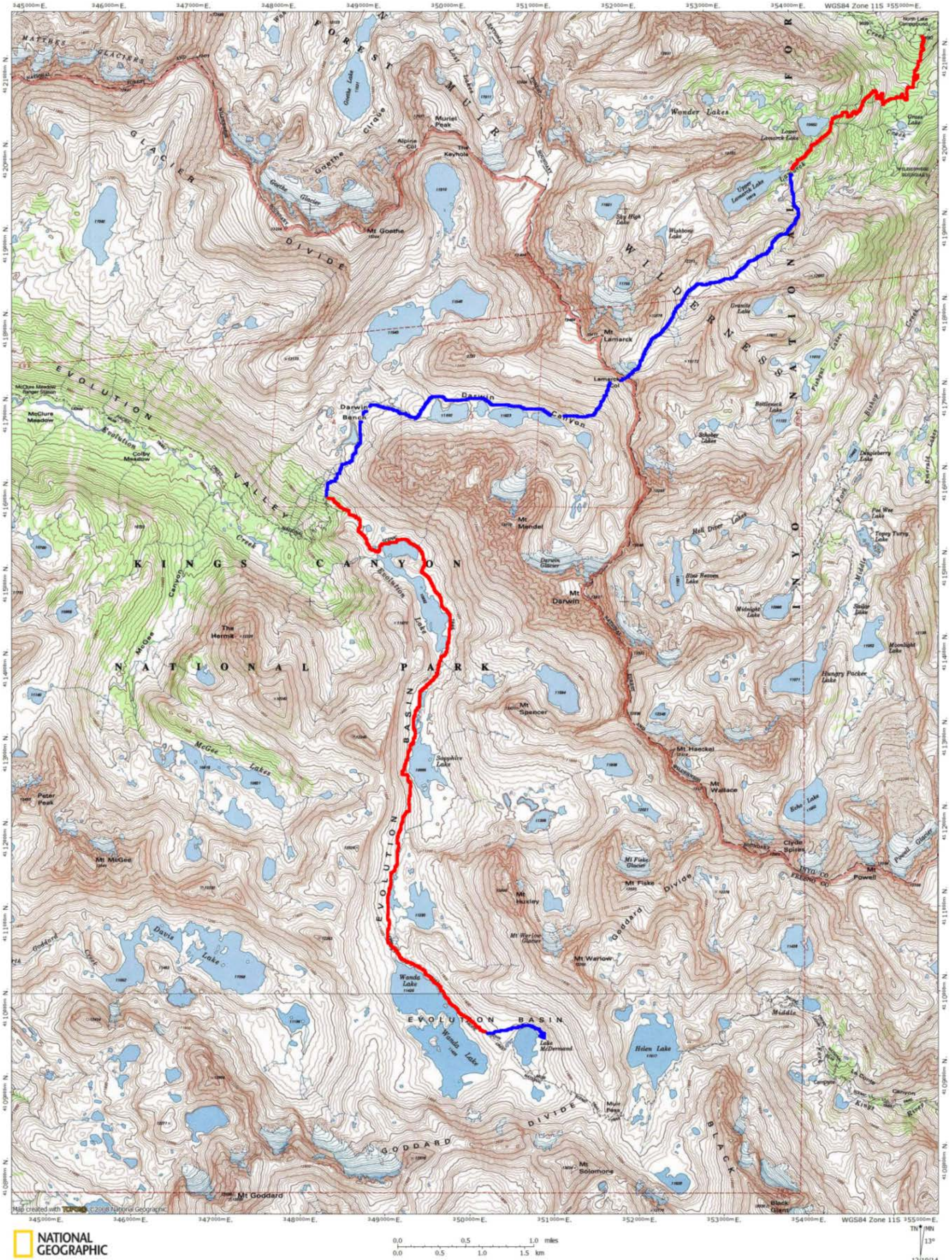
Photo 6. Widening in channel approximately 400 m downstream of Lake 10511. Facing north.



Map 1. Location of Upper Evolution proposed restoration site in Kings Canyon National Park, CA.



Map 2. Proposed restoration site in Upper Evolution, Kings National Park, CA.



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Map 3. Suggested route into Upper Evolution Basin via Lamarck Col. Established trails are highlighted in red. Unmaintained or off trail portions of the route are shown in blue.

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