ATTACHMENT H

LIFE HISTORY AND HABITAT REQUIREMENTS OF FISH SPECIES IN THE PROJECT AREA

Attachment H - Life History and Habitat Requirements of Fish Species in the Project Area

1.1 Overview

A summary of fish species found in the Project Area and their status is summarized in Table Attachment H-1.

Table Attachment H-1. The Status of Fish Species of Waters in the Big Creek System.

Common Name	Scientific Name	Status	Special Status
Hardhead	*Mylopharodon conocephalus*	N	CSC, USFS
Sacramento pikeminnow	*Ptychocheilus grandis*	N	
Sacramento sucker	*Catostomus occidentalus*	N	
Rainbow trout	*Oncorhynchus mykiss*	N/I[1]	
Golden trout	*Oncorhynchus mykiss aguabonita*	N/I	FSC, CSC[2]
Brown trout	*Salmo trutta*	I	
Brook trout	*Salvelinus fontinalis*	I	
Prickly sculpin	*Cottus asper*	N	
Kokanee	*Oncorhynchus nerka*	I	
Bluegill	*Lepomis macrochirus*	I	
Crappie	*Pomoxis spp.*	I	
Smallmouth bass	*Micropterus dolomieu*	I	
Carp	*Cyprinus carpio*	I	

Legend:

N = Native

I = Introduced

FSC = Federal Species of Concern

CSC = California Species of Special Concern
USFS = Sensitive Species

[1] Rainbow trout are native to California, and were historically absent from the upper-most reaches of the South Fork San Joaquin River. Spawning anadromous rainbow trout (steelhead) may have migrated up the San Joaquin River into the lower reaches of the Project area prior to the installation of dams. Stocking of rainbow trout into the Project area included a variety of genetic strains of fish, including Kamloops, B.C., Whitney, and Coleman, among others.

[2] The special status of golden trout is only applicable to populations in their native range, the South Fork Kern River. The Project Area is outside of its native range.

The phenology of the most common trout species found in the streams of the Project Area is presented in Figure Attachment H-1. The phenology of members of native transition zone species found in stream of the Project Area is presented in Figure Attachment H-2. Life history and habitat requirements of fish species present in the Project Area are presented in the following sections.

1.2 Hardhead (*Mylopharodon conocephalus*)

Hardhead become mature in their third year (Moyle 2002). Spawning is believed to begin in April and May (Reeves 1964, Grant and Maslin 1997 as cited in Moyle 2002), with peak spawning estimated to occur during May and June. During these months, hardhead may migrate to tributaries to lay eggs. Limited information is available pertaining to hardhead spawning activity, but it is assumed to be similar to that of Sacramento pikeminnow. It is assumed that mass spawning occurs and that eggs are broadcast over gravel riffles, runs or the heads of pools, in streams or over gravel areas along the margins of lakes and reservoirs (Moyle 2002).

Hardhead are omnivores, foraging for benthic invertebrates and aquatic plant material on the bottom, eating drifting insects and algae (Alley 1977 a, b as cited in Moyle 2002), and in reservoirs feeding on zooplankton (Wales 1946 as cited in Moyle 2002). Small hardhead juveniles (less than 20 cm standard length [SL]) feed on aquatic insect larvae and small snails (Reeves 1964). After reaching 20 cm SL, hardhead primarily feed on aquatic plants and invertebrates in quiet water. Typically, juvenile hardhead grow an average of 60 to 70 mm per year, eventually decreasing their growth rate as the fish get older, but growth can vary between river systems. Feather River hardhead were determined to be (using scale analysis) nine to ten years, but older fish may exist (Moyle 2002).

Hardhead are typically found in undisturbed, mid- to low-elevation streams, up to 1,450 m maximum elevation. Hardhead prefer well-oxygenated water with summer water temperatures in excess of 20°C and prefer temperatures of 24°C to 28°C based on laboratory experiments. These experiments primarily focused on juvenile hardhead. Preliminary work by Cech suggests that adult hardhead acclimated to water temperatures below 20°C prefer temperatures at or above 20°C (J. Cech, University of California at Davis, pers. comm. 2006).

Hardhead prefer deep pools (greater than one meter deep and considerably deeper in the Horseshoe Bend Reach of the San Joaquin River downstream of Redinger Lake) with slow water velocities. Adult hardhead tend to position themselves in the lower half of the water column in a stream and near the surface in a lake or reservoir.

Hardhead usually occur in the same habitats as Sacramento sucker and Sacramento pikeminnow. They are almost never found in areas where Sacramento pikeminnow is absent. In addition, hardhead are rarely found in an environment that has well-established centrarchid populations (Mayden, et al. 1991, Moyle and Daniels 1982 as cited in Moyle 2002) or an environment that has been heavily impacted by man (Baltz and Moyle 1993). They are rarely found in reservoirs, but one exception is Redinger Lake downstream of the Big Creek No. 3 Project Area, where permanent a hardhead population is established.

The early life history of the hardhead is not well known. Presumably, larval and postlarval hardheads remain along stream edges in dense cover of flooded vegetation

or fallen branches, then move into deeper habitats or are swept downstream into main rivers and perhaps concentrate in low-velocity areas near the mouth (Moyle 2002).

The moderate velocities preferred by large hardheads would most commonly be found in runs or at the heads of pools. In studies conducted in the Pit River, hardhead were most frequently observed in runs and pools and rarely in riffles (BioSystems and UC Davis 1985). Adult fish were more commonly encountered in pools, while juveniles were more common in runs. Hardhead were also found to be abundant in reservoirs of the Pit River system. They were usually associated with the surface waters at the head end of the reservoirs.

Moyle (2002) citing Knight (1985) and others evaluated the temperature preference of several species of native California fishes. Knight (1985) determined the temperature preference of fish acclimated at different temperatures. From these data, final temperature preferenda were defined. Knight also evaluated the CTM of these species. Small sample sizes (generally ten fish at each of four temperatures tested) precluded determination of relationships between fish size and temperature preferences. Most of the hardhead used were juveniles, and body weights ranged from 0.47 to 249.3 grams.

Knight (1985) found hardhead acute preferred temperatures ranging from 15.3°C at an acclimation temperature of 10°C to 28.6°C at an acclimation temperature of 30°C. The final acute preferred temperature range was 28.4°C. The CTM was not determined for hardhead. At higher temperatures, hardhead are relatively intolerant of low oxygen levels (Cech et al. 1990).

1.3 Sacramento Sucker (*Catostomus occidentalis*)

Moyle (2002) states that Sacramento suckers first spawn at an age of about four to six. Spawning generally takes place in February through June, depending on water temperatures, and may continue into July or August in some systems. Spawning is triggered by water temperatures rising to 5.6°C to 10.6°C. Suckers are known to swim 20 km upstream to spawn. Suckers, in tributaries, spawn over gravel riffles, whereas suckers in lakes may spawn along shorelines. Spawning occurs in groups, with an individual female being accompanied by several males. Females have been known to carry up to 11,000 eggs. Fertilized eggs are broadcast over gravel, where they sink to the bottom and adhere to the rocks, or bounce along the bottom until caught in gravel or washed to a small backwater (Moyle 2002). Embryos hatch in two to four weeks and larvae initially remain in or among the gravel. Larval suckers swim up in the water column, assuming a benthic orientation, as they grow larger. Young-of-the-year exercise schooling behavior in tributary streams. Juveniles that were spawned in tributary streams may spend two to three years in some streams before moving to a large river or reservoir during high flows. In streams that have resident sucker populations, juveniles stay in shallow, dense cover as long as possible. Adult suckers also appear to school, but are comprised of individuals orientating themselves to optimal foraging sites in a stream, usually at the head of pools.

Suckers forage most actively at night, when they move up into riffles to feed. Their primary food is algae, diatoms, and invertebrates. Invertebrates become increasingly important as the fish grow larger, although algae remain an important component of the diet throughout life. Suckers may grow 12 to 87 mm per year after their first year, depending on local conditions (e.g., temperature and food supply) (Moyle 2002) and may considerably exceed ten years of age and 50 cm in length in larger water bodies (Scoppetone 1988 as cited in Moyle 2002).

Sacramento suckers are found in a wide variety of streams, from cold mountain streams to valley floor rivers. They are most abundant in larger streams and rivers at moderate elevations (200 to 600 m) in the transitional areas between the cold and warmwater reaches. Larval suckers are found concentrated over detritus bottoms or in emergent vegetation in warm, protected stream margins, while juvenile suckers are found close to the bottom in shallow, low velocity water along stream margins (Moyle 2002). Small fish are found in the shallowest water, but in the absence of predatory fish species, use deeper water (Brown and Moyle 1993). Adults are most numerous in larger streams, and in the day are found in deep pools and runs or beneath undercut banks near riffles. They generally are found in areas with cover from avian predators (Moyle 2002).

In the Pit River, suckers were most commonly observed in pools and riffles and less commonly in runs (BioSystems and UC Davis 1985). Schools of young fish can often be seen in shallow sandy backwater areas and slow moving areas of the main channel. The distribution in pools and riffles likely corresponds to the location of adults versus that of juveniles and fry. In the Horseshoe Bend Reach of the San Joaquin River, approximately 75 percent of the Sacramento suckers (primarily young-of-the-year fish less than 75 mm FL) were observed in pool habitats (SCE 1997).

Sacramento suckers are found in a wide range of water temperature regimes, including streams with temperatures that rarely exceed 15 to 16°C and streams where temperatures are as high as 29°C to 30°C (Cech, et al. 1990, Moyle 2002). Preferred temperatures appear to be about 20°C to 25°C (Knight 1985). Sacramento sucker acute temperature preferenda were determined at acclimation temperatures of 10°C, 15°C, and 20°C (Knight 1985). Acute temperature preferenda ranged from 20.1°C at the lowest acclimation temperature to 23.2°C at the highest acclimation temperature. CTM studies were performed at acclimation temperatures ranging from 15°C to 30°C. CTM increased with acclimation temperature from 30.9°C to 36.0°C. The upper lethal temperature for suckers acclimated to warm water in the laboratory was 36°C.

1.4 Sacramento Pikeminnow (*Ptychocheilus grandis*)

Sacramento pikeminnow reach sexual maturity at an age of three or four years and can travel long distances to spawn (Moyle 2002). Spawning generally occurs in April and May (Taft and Murphy 1950, Mulligan 1975, Grant 1992), although larvae have been collected into July (Wang 1986), and is triggered when water temperatures reach 14°C. The spawning behavior of pikeminnow has not been well documented. Pikeminnow in large rivers or reservoirs often move into small tributaries to spawn while fish in small to medium-size tributaries usually move to the nearest riffle. Ripe pikeminnow migrate

upstream to spawn in gravel riffles (or over rocks) in streams or on gravel areas near shore, in lakes or reservoirs. In larger streams, pikeminnow have been observed to spawn in the lower ends of pools above where they break into riffles (Taft and Murphy 1950). The female dips down to release a small batch of eggs, while one to six males simultaneously release milt into the water, which fertilizes the eggs. The eggs drift down into the gravel or rocks, and adhere to the substrate. Sacramento pikeminnow are known to have a high fecundity, based on Burns (1966) observations of a female carrying 17,730 eggs. Fecundity is related to size, and estimates range from 15,000 to 40,000 eggs per female for fish 31 to 65 cm SL (Moyle 2002).

Juvenile pikeminnow prey on surface and bottom-dwelling aquatic insects. Once they reach 18 cm SL, pikeminnow become piscivorous and start feeding on smaller fish and crayfish. Fish larger than 20 cm SL feed on fish and crayfish, and occasionally on large stoneflies, frogs and small rodents (Moyle 2002). Pikeminnow from the Russian River have been aged at 16 years, and may live longer (Grant 1992 cited in Moyle 2002). Prior to the introduction of non-native predatory fish such as largemouth bass, large pikeminnows were at the top of the aquatic food chain throughout the Central Valley. Pikeminnow tend to occupy one area in a stream, but are also known to migrate upstream (when water level is high) or downstream (when water level is low) for food. Sacramento pikeminnow tend to have a faster growth rate in large, warm rivers and lower growth rates in small streams (Moyle 2002). A Sacramento pikeminnow measuring 115 cm SL was caught in Avocado Lake, Fresno County (Moyle 2002).

Sacramento pikeminnows are abundant in intermittent and permanent streams (elevation of 100 - 650 m). Older pikeminnow prefer pool habitats that are deep, have adequate amount of shade, and that have a sandy/boulder substrate. Adults tend to hide underneath rock ledges and logs during the day, and come out of hiding at night, to actively seek out prey. After hatching, young Sacramento pikeminnow school in shallow pool edges. When the small fish become more active swimmers, they disperse into deeper water, especially runs and along riffles in cover, and juveniles can disperse widely in their first year (Moyle 2002).

In the Pit River, pikeminnow were most commonly observed in pool habitats, followed by runs (BioSystems and UC Davis 1985). They were often absent in riffles. In the Horseshoe Bend Reach of the San Joaquin River, all of the Sacramento pikeminnow (primarily young-of-the-year less than 75 mm FL) were found in pool habitats (SCE 1997).

Unlike juveniles, adult pikeminnow are considered to be solitary and do not school. Individuals have been observed to move downstream two to 23 km (1.2 to 14.3 mi.) to find overwintering habitat (habitat with deep cover that can serve as velocity refuge during high flows [Grant 1992]), but then moved back to their original habitat for the summer (Harvey and Nakamoto 1999 as cited in Moyle 2002).

Pikeminnow are found in summer water temperatures of 18°C to 28°C (Brown and Moyle 1993, Baltz, et al. 1987, Dettman 1976 cited in Moyle 2002) and often seek warmer temperatures if other habitat features are appropriate (Baltz, et al. 1987,

Dettman 1976 cited in Moyle 2002). Knight (1985) determined Sacramento pikeminnow had a preference for average water temperatures ranging from 13.2°C to 27.8°C at acclimation temperatures of 10°C and 30°C, respectively. The final preferred temperature for pikeminnow was 26.0°C. The CTM for pikeminnow increased with acclimation temperature, beginning at 28.3°C for an acclimation temperature of 10 and peaking at 38.0°C at an acclimation temperature of 30°C. Temperatures above 38°C are lethal (Knight 1985).

1.5 Trout

Rainbow Trout (*Oncorhynchus mykiss*)

Rainbow trout has a flexible biology and life history behavior, and fish growth can be variable. In small streams and high mountain lakes, rainbow trout seldom live longer than six years of age or grow larger than 40 cm total length. Most wild rainbow trout reach sexual maturity in their second or third year and usually spawn between February and June, depending on water temperature and strain (McAfee 1966). In colder waters at high altitudes, spawning may occur as late as July or early August (McAfee 1966). Rainbow trout in other similar South Fork San Joaquin River tributary streams have been found to spawn from April through June, according to CDFG (Loudermilk 2001).

Rainbow trout spawn in gravel, usually in riffles. The eggs hatch in 15 weeks at 3.5°C and 11 weeks at 5°C (Stickney 1991). The fry emerge from the gravel beginning two to three weeks later, depending upon temperature. Juvenile and adult rainbow trout may migrate into a lake or other downstream areas or remain in the stream defending a small home range (Moyle 2002).

For the first year or two of life rainbow trout inhabit clear, cool, fast flowing water. Rainbow trout prefer streams with ample aquatic cover such as riparian vegetation or undercut banks. As fish grow in size, habitats generally shift from riffles for the smallest fish to runs for intermediate sized fish and pools for the largest fish (Moyle 2002). Stream dwelling fish feed mostly on drifting invertebrates, but will also take benthic invertebrates. In lakes feeding habits depend on the availability of prey. Rainbow trout in lakes may feed on zooplankton, benthic invertebrates, or small fish.

There is substantial regional variability in rainbow trout temperature tolerances reported in the published literature, which indicates that that local information is required for management decisions. Recent research specific to California strains of rainbow trout / steelhead, as well as recent literature reviews, suggest that temperature tolerances of steelhead / rainbow trout in the Central Valley may be higher than races in the Pacific Northwest. Additional information on temperature requirements of rainbow trout is presented in Attachment I – Trout Temperature Requirements (Literature Review) (SCE 2007; Volume 4 (Book 5)).

Myrick and Cech (2000b) found that growth rates of two strains of resident California rainbow trout (Eagle Lake and Mt. Shasta, both stocked with hatchery fish) studied at temperatures of 10°C to 25°C increased to a maximum near 19°C, and declined at

temperatures greater than 19°C. These growth rates were consistently higher than those of American or Feather River steelhead, and Myrick and Cech (2001) suggest that hatchery selection on the resident trout strains may have been a factor. Comparing results of their growth studies with studies conducted with Oregon steelhead (Wurtsbaugh and Davis 1977a, 1977b), Myrick and Cech (2001) noted some growth rate differences between steelhead in California and those in the north. Myrick and Cech (2001) suggest their limited data hint at physiological differences in responses to temperature, between steelhead stocks from California and from northern latitudes, but indicate large-scale experiments are needed before clear conclusions can be drawn.

An experimentally established UILT for steelhead is 23.9°C (Bjornn and Reiser 1991, citing Bell 1986) (acclimation temperature of 20°C and 50 percent survival in 1,000 min.). However, this value was based on studies with steelhead in the Pacific Northwest. Lee and Rinne (1980, cited in Bjornn and Reiser 1991) reported a CTM value of 29.4°C for rainbow trout (acclimation at 20°C and temperature increase of 1.2°C/h). Citing Charlon, et al. (1970), who studied hatchery rainbow trout in France, Bjornn and Reiser (1991) also reports an ILT of 25.0°C (24-hour exposures).

Myrick and Cech's (2001) review indicated that steelhead can be expected to show significant mortality at chronic temperatures exceeding 25°C, although they tolerate temperatures as high as 29.6°C for short periods of time. However, the fish experience sub-lethal effects at temperatures below these limits. The ability of salmonids to tolerate elevated temperatures is a function of exposure time.

Golden Trout (*Oncorhynchus mykiss aguabonita*)

Golden trout are native to the upper Kern River basin at elevations above 2,300 meters (7,456 feet) (Moyle 2002). They are not native to the Project Area.

The close relationship between rainbow trout and golden trout allows the two species to crossbreed. Growth in golden trout is generally slow due to the short growing season of high altitude waters and the low productivity of their native waters. Golden trout can live up to nine years and can grow to 35 to 43 cm fork length (FL) in high elevation lakes and streams. Golden trout mature in their third or fourth year and spawn when water temperatures reach 10°C to 15°C and high spring flows decline. Spawning has been observed in lakes, but is not generally successful. However, it is not known whether the spawning period of hybrids is more similar to that of rainbow trout or golden trout. Golden trout eggs hatch in about 20 days at 14°C. Preferred habitat includes pools and areas with undercut banks, aquatic vegetation, and sedges (Moyle 2002).

Golden trout feed on invertebrates. Golden trout seem to do poorly in competition with other salmonids, especially eastern brook trout (McAfee 1966). However, they coexist naturally with Sacramento sucker in their native range, and probably coexisted with Sacaremento pikeminnow and hardhead (Moyle 2002).

Brown Trout (*Salmo trutta*)

Brown trout are a nonnative gamefish introduced into Project area waters. Brown trout mature in their second or third year and will spawn, depending on water levels and stream temperature, in the fall or winter. In the Project area, brown trout may begin their spawning migration as soon as early September. However, spawning sites are not chosen until stream temperatures begin to significantly cool (Moyle 2002). Peak spawning activity generally does not occur until October and November and tapers off in December. Eggs hatch after between 11 to 16 weeks (Loudermilk 2001). For a period, typically June though October, brown trout fry inhabit quiet water close to banks among large rocks or overhanging vegetation.

Large brown trout are highly piscivorous and can prey on young of their own or of other trout species. Brown trout growth is variable and depends on habitat conditions. Usually brown trout grow faster in large lakes and reservoirs than in streams, but in high alpine habitats growth may be low in both (Moyle 2002). Surface water temperatures in large lakes may be warmer than smaller high altitude mountain lakes, and, therefore, contribute to a better and longer growing season.

Moyle (2002, citing Armour 1994) reports preferred temperatures of 12°C to 20°C and optimal temperatures that appear to be approximately 17°C to 18°C, although high growth rates have been found in temperatures of 12°C to 18°C. Brown trout can survive temperatures up to 28°C to 29°C for short periods of time, depending upon acclimation temperature.

In a USFWS publication, Raleigh et al. (1986) describe temperature optima for brown trout juveniles as 7°C to 19°C, with a range of 0°C to 27°C, similar to adults. Optimal growth temperature for juvenile brown trout is described as 12°C, with good growth occurring between 7°C and 19°C (citing Frost and Brown 1967, Brown 1973). Furthermore, juveniles in a laboratory experiment showed a preference for 17.6°C (Coutant 1977).

Oranguren, et al. (2001), who studied juvenile brown trout in Spain, fitted their data to the model developed by Elliott et al. (1995). Their estimate of temperature for maximum growth was 16.87 ± 0.12°C, based on constant temperature exposure over 14 days. Juvenile trout grew above 90 percent of their maximum potential between 13.78°C and 19.59°C. As experimental temperatures increased, growth increased exponentially, reached a plateau approximately between 14°C and 20°C, then dropped sharply at higher temperatures. Experimental temperatures were as high as 24°C. The estimated temperature values for maximum growth were higher than those published by Elliott and Hurley (1995). The authors suggest differences in experimental conditions may have been a factor, such as feeding regime (e.g. energy content of food), acclimation, or length of the trials.

Brook Trout (*Salvelinus fontinalis*)

Brook trout rarely live longer than four to five years of age (Moyle, 2002). Maturity in males can occur at the end of their first year of life, but is more common in their second year. Females may mature between their second and fourth year of life. Brook trout may begin their spawning migration in mid-September, but specific timing depends on water temperatures. Brook trout also are capable of spawning in lakes if suitable habitat exists. The peak spawning period lasts from October to December.

Eggs hatch after 12-16 weeks at water temperatures of 2°C to 5°C. After hatching, the alevins remain in the gravel for three to four days until the yolk sac is absorbed. In streams and lakes, the fry move to the shallow edges among vegetation or backwater areas for cover (Moyle, 2002). Fry will remain in the shallows from June to October.

In streams, juvenile and adult fish will defend territories (often associated with areas of cover) against other trout. In lakes, juvenile and adult fish may move individually about in open water, schooling only when alarmed. Growth in brook trout depends on a number of factors, including length of growing season, water temperature, population density, and food availability. Competition with other introduced salmonids, and the factors listed above, frequently prevent brook trout from growing larger than 30 cm total length.

Brook trout are among the most cold tolerant of the trout species. They prefer temperatures of 14°C to 19°C, can survive temperatures up to 26°C if acclimated, but growth is poor at temperatures above 19°C (Moyle 2002).

1.6 Kokanee (*Oncorhynchus nerka*)

Kokanee are the non-anadromous form of sockeye salmon and have been introduced in many of California's cold-water lakes. Kokanee are pelagic zooplankton feeders. The diet of kokanee changes little as they grow larger; kokanee feed mainly on Daphnia, copepods, emerging insects and, on occasion, larval fish. Kokanee cease all feeding activity during the winter and prior to spawning.

Spawning kokanee are usually between two and four years of age, depending on growing conditions and genetic stock. Most spawning kokanee are at least 20 cm total length, but mature fish as small as 16 cm total length have been recorded. Depending on the genetic stock and the lake and stream temperatures, kokanee spawn between September and February. Kokanee may spawn in streams or lakes (usually in water less than eight meters in depth) with suitable gravel substrate. Just prior to spawning, kokanee congregate at the mouths of streams or in the vicinity of suitable lake spawning areas. Like other salmon, spawning kokanee attempt to return to the stream in which they were hatched. Spawning behavior is like that of other salmon; the females build redds while the males defend the area from other males. Spawning success is particularly low among kokanee, but is compensated by a high survival rate for the eggs that are laid, based on the literature. The fry emerge in April through June and

immediately migrate downstream and generally do not start feeding until they reach the lake.

Kokanee inhabits well-oxygenated waters of reservoirs between 10°C and 15°C. Kokanee requires water temperatures between 6°C and 13°C to spawn. Kokanee grow quickly compared to other salmonids, but typically do not attain the large sizes observed in some of the other species.

1.7 Smallmouth Bass (*Micropterus dolomieu*)

Smallmouth bass were introduced into California in 1874 and have since spread to most of the suitable waters. In California, smallmouth bass tend to be most abundant at elevations between 100 and 1,000 m. In rivers and streams, they are usually found in the same habitats as pikeminnow, sucker, and hardhead, members of the native transition zone fish community (Moyle 2002). In the Project Area, they generally are found in Shaver Lake.

Spawning occurs during their third or fourth year. When water temperatures reach 13 to 16°C (usually in April) males begin to build nests in rocky bottoms at a depth of three feet in reservoirs or quiet areas of streams. Males will guard the nest until the eggs hatch in three to 10 days. After hatching, the sac fry spend three to four days in the nest. The male herds and guards the fry for an additional one to three weeks; they then disperse into shallow water. Young fry would be expected to be present during early summer (Moyle 2002).

For the first month or two, fry feed mainly on rotifers and small crustaceans. By the time they are two to three inches long, they feed primarily on aquatic insects and fish fry. Once smallmouth bass exceed four inches, they feed primarily on fish and large invertebrates, especially crayfish. In addition, smallmouth bass also feed on amphibians. Moyle (2002) notes that smallmouth bass are frequently cannibalistic.

Growth of smallmouth bass depends upon food availability and habitat conditions. Smallmouth bass are normally found in water approximately 20°C to 27°C, preferring pools and areas with abundant cover.

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Figures

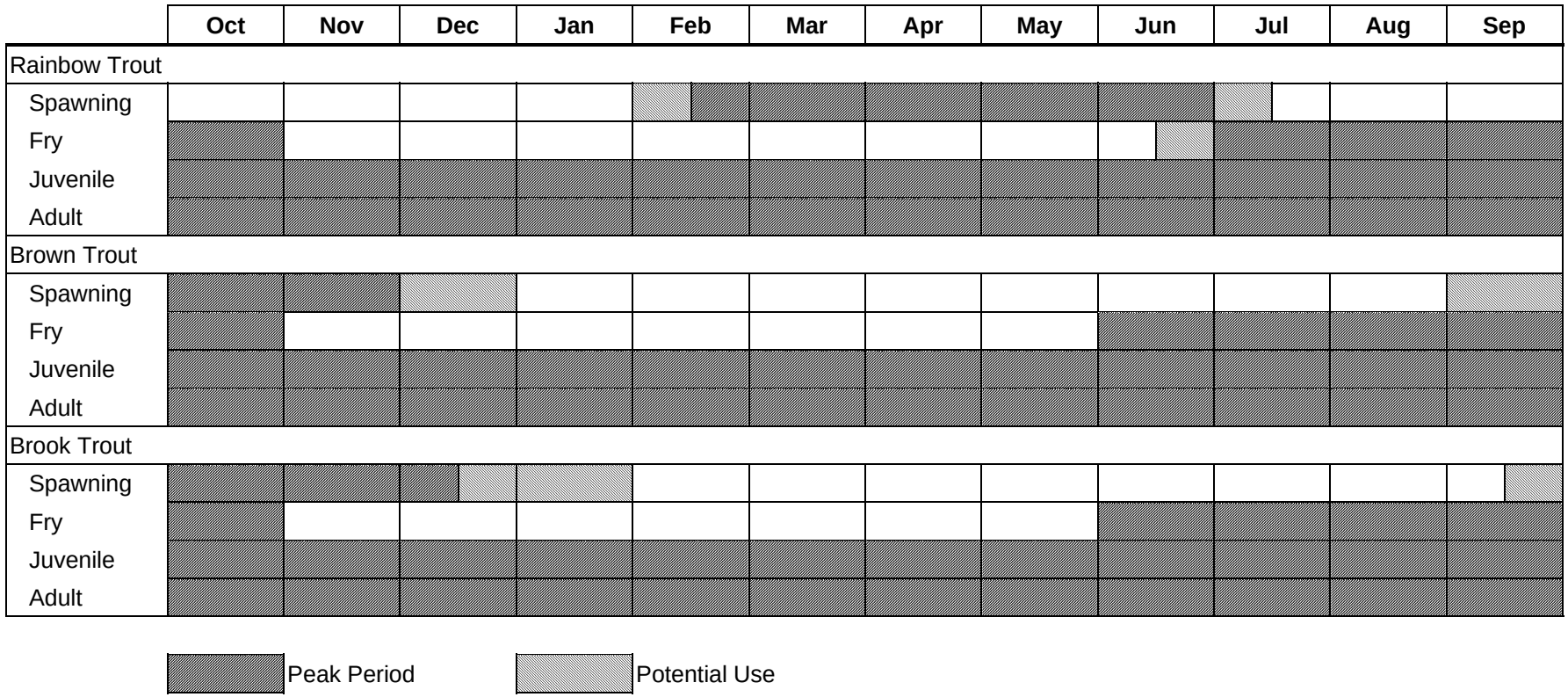

Figure Attachment H-1. Phenology of Trout Species Observed in Streams of the Project Area[1].

[1] Timing of lifestages may differ with elevation and snowpack.

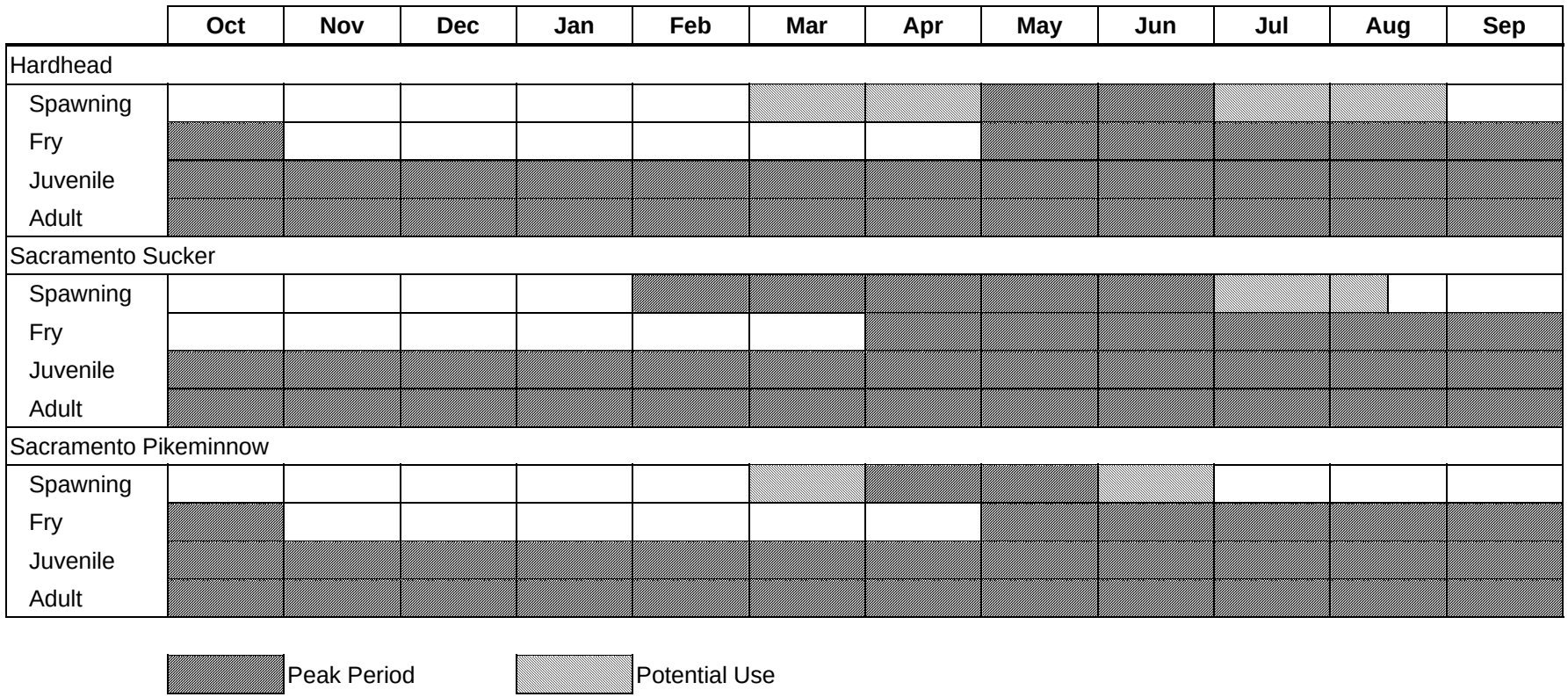

Figure Attachment H-2. Phenology of Native Transition Zone Species Observed in Streams of the Project Area.