DEPARTMENT OF THE INTERIOR

Fish and Wildlife Service

50 CFR Part 17

[Docket No. FWS–R6–ES–2011–0092; MO 92210–0–0008–B2]

Endangered and Threatened Wildlife and Plants; 12-Month Finding on a Petition To List Northern Leatherside Chub as Endangered or Threatened

AGENCY: Fish and Wildlife Service, Interior.

ACTION: Notice of 12-month petition finding.

SUMMARY: We, the U.S. Fish and Wildlife Service (Service), announce a 12-month finding on a petition to list the northern leatherside chub (*Lepidomeda copei*) as endangered or threatened and to designate critical habitat under the Endangered Species Act of 1973, as amended (Act). After review of all available scientific and commercial information, we find that listing the northern leatherside chub rangewide is not warranted at this time. We ask the public to submit to us any new information that becomes available concerning the threats to the northern leatherside chub or its habitat at any time.

DATES: The finding announced in this document was made on October 12, 2011.

ADDRESSES: This finding is available on the Internet at *http://www.regulations.gov* at Docket Number FWS–R6–ES–2011–0092. Supporting documentation we used in preparing this finding is available for public inspection, by appointment, during normal business hours at the U.S. Fish and Wildlife Service, Utah Ecological Services Field Office, 2369 West Orton Circle, Suite 50, West Valley City, UT 84119. Please submit any new information, materials, comments, or questions concerning this finding to the above street address.

FOR FURTHER INFORMATION CONTACT: Larry Crist, Field Supervisor, Utah Ecological Services Field Office (see **ADDRESSES**); by telephone at 801–975–3330; or by facsimile at 801–975–3331; or Brian Kelly, Field Supervisor, Idaho Ecological Services Field Office; by telephone at 208–378–5243; or by facsimile at 208–378–5262. If you use a telecommunications device for the deaf (TDD), please call the Federal Information Relay Service (FIRS) at 800–877–8339.

SUPPLEMENTARY INFORMATION:

Background

Section 4(b)(3)(B) of the Act (16 U.S.C. 1531 *et seq.*) requires that, for any petition to revise the Federal Lists of Endangered and Threatened Wildlife and Plants that contains substantial scientific or commercial information that listing the species may be warranted, we make a finding within 12 months of the date of receipt of the petition. In this finding, we will determine that the petitioned action is: (1) Not warranted; (2) warranted; or (3) warranted, but the immediate proposal of a regulation implementing the petitioned action is precluded by other pending proposals to determine whether species are endangered or threatened, and expeditious progress is being made to add or remove qualified species from the Federal Lists of Endangered and Threatened Wildlife and Plants. Section 4(b)(3)(C) of the Act requires that we treat a petition for which the requested action is found to be warranted but precluded as though resubmitted on the date of such finding, that is, requiring a subsequent finding to be made within 12 months. We must publish these 12-month findings in the **Federal Register**.

Previous Federal Actions

On July 30, 2007, we received a petition dated July 24, 2007, from Forest Guardians (now WildEarth Guardians), requesting that the Service: (1) Consider all full species in our Mountain Prairie Region ranked as G1 or G1G2 by the organization NatureServe, except those that are currently listed, proposed for listing, or candidates for listing; and (2) list each species as either endangered or threatened. The petition included the northern leatherside chub (*Lepidomeda copei*), which is addressed in this finding. The petition incorporated all analysis, references, and documentation provided by NatureServe in its online database at *http://www.natureserve.org/* into the petition. The document clearly identified itself as a petition and included the petitioners' identification information, as required in 50 CFR 424.14(a). We sent a letter to the petitioners, dated August 24, 2007, acknowledging receipt of the petition and stating that, based on preliminary review, we found no compelling evidence to support an emergency listing for any of the species covered by the petition.

On March 19, 2008, WildEarth Guardians filed a complaint (1:08–CV–472–CKK) indicating that the Service failed to comply with its mandatory duty to make a preliminary 90-day finding on their two multiple species petitions—one for mountain-prairie species, and one for southwest species.

On February 5, 2009 (74 FR 6122), we published a 90-day finding on 165 species from the petition to list 206 species in the mountain-prairie region of the United States as endangered or threatened under the Act. We found that the petition did not present substantial scientific or commercial information indicating that listing was warranted for these species and, therefore, did not initiate further status reviews in response to the petition. Two additional species were reviewed in a January 6, 2009, 90-day finding (74 FR 419) and, therefore, were not considered further in the February 5, 2009, 90-day finding. For the remaining 39 species, we deferred our findings until a later date. One species of the 39 remaining species, *Sphaeralcea gierischii* (Gierisch mallow), was already a candidate species for listing; therefore, 38 species remained. On March 13, 2009, the Service and WildEarth Guardians filed a stipulated settlement in the District of Columbia Court, agreeing that the Service would submit to the **Federal Register** a 90-day finding on the remaining 38 mountain-prairie species by August 9, 2009.

On August 18, 2009, we published a notice of 90-day finding (74 FR 41649) on 38 species from the petition to list 206 species in the mountain-prairie region of the United States as endangered or threatened under the Act. Of the 38 species, we found that the petition presented substantial scientific and commercial information for 29 species indicating that a listing may be warranted. The northern leatherside chub addressed in this 12-month finding was included in the list of 29 species. We initiated a status review of the 29 species to determine if listing was warranted. We also opened a 60-day public comment period to allow all interested parties an opportunity to provide information on the status of the 29 species. The public comment period closed on October 19, 2009. We received 224 public comments. Of these, five specifically mentioned northern leatherside chub. All substantial information we received was carefully considered in this finding. This notice constitutes the 12-month finding on the July 24, 2007, petition to list the northern leatherside chub as endangered or threatened.

Species Information

The northern leatherside chub (*Lepidomeda copei*) is a rare desert fish in the minnow family (Cyprinidae) that occurs in northern Utah and Nevada, southern and eastern Idaho, and western

Wyoming (Johnson *et al.* 2004, pp. 842–843; Utah Division of Wildlife Resources (UDWR) 2009, pp. 28–30; McAbee 2011, entire). The species is native to smaller, mid-elevation, desert streams in the northeastern portions of the Great Basin region (draining to the Great Salt Lake) and the southern and eastern portions of the Pacific Northwest Region (draining to the Pacific Ocean) (Johnson *et al.* 2004, pp. 842–843; UDWR 2009, pp. 28–30). Like many western North American non-game fish species, little was known about its biology, ecology, or status until recently (Belk and Johnson 2007, pp. 67–68).

Taxonomy and Species Description

The northern leatherside chub is one of two species, along with the southern leatherside chub (*Lepidomeda aliciae*), recently re-classified from the single species 'leatherside chub' (*Snyderichthys copei* or *Gila copei*) (Johnson *et al.* 2004, pp. 841, 852). Throughout the remainder of this finding, references to leatherside chub indicate data collected before the two species were delineated, and references to southern leatherside chub and northern leatherside chub indicate data specific to each species, exclusively. Because the northern and southern species were only recently separated, most species descriptions and life-history investigations are a combination of the two species. While many characteristics are common to both species, we will describe characteristics of only the northern leatherside chub when possible.

The taxonomic history of leatherside chub is complex. Even when considered a single species, taxonomists classified the leatherside chub in at least seven different genera over the past century and a half (Johnson *et al.* 2004, p. 841). The type locality for leatherside chub (*Squalius copei*; Jordan and Gilbert 1881) is from the Bear River at Evanston, Wyoming (UDWR 2009, p. 24). Classification by Miller in the mid-twentieth century (1945) placed leatherside chub in the monotypic genus *Snyderichthys,* but shortly thereafter Uyeno (1960) assigned it to the genus *Gila* (the chubs), subgenus *Snyderichthys* (UDWR 2009, p. 25). Many fisheries texts accepted *Gila copei* as the taxonomic classification over the next 40 years (Sigler and Miller 1963, p. 74; Sigler and Sigler 1996, p. 77), but acceptance was not unanimous, as evidenced by the American Fisheries Society supporting *Snyderichthys copei* in 2004 (UDWR 2009, p. 25). Taxonomic discrepancy was not fully rectified until a short time ago. Recent research demonstrated that what was previously considered the 'leatherside chub' is in fact two distinct species with discrete geographic, ecological, morphological, and genetic characteristics (Johnson *et al.* 2004, pp. 841, 852). Moreover, neither species belongs in the previously accepted genera, but rather both belong in the genus *Lepidomeda,* a group commonly referred to as the spinedaces (Johnson *et al.* 2004, pp. 841, 852).

Three different species concepts validate this taxonomic revision. Genetic analysis endorses two evolutionarily separate species under the phylogenetic species concept (defines a species as a set of organisms with a unique genetic history) (Johnson and Jordan 2000, pp. 1029, 1033; Johnson *et al.* 2004, pp. 841, 851). In addition, morphologic (cranial shape) and ecological (feeding and growth rates) divergence support two distinct species under the similarity and ecological species models, respectively (Johnson *et al.* 2004, p. 851). It also is worth noting that current taxonomy aligns with discrete geographic distributions of the species, with the unoccupied Weber River separating the two species' ranges and the uninhabitable Great Salt Lake preventing natural interaction between individuals of the two species (Belk and Johnson 2007, p. 69). Supported by multiple lines of evidence indicating that southern (*Lepidomeda aliciae*) and northern (*L. copei*) leatherside chub are two distinct species, the American Fisheries Society now recognizes the two species as such (Jelks *et al.* 2008, p. 390). Because northern leatherside chub is an acknowledged species, it is a listable entity under the Act.

The northern leatherside chub is a small fish, less than 150 millimeters (mm) (6 inches (in.)) in length, that received its common name from the leathery appearance created by small scales on a trim, tapering body (Sigler and Sigler 1996, p. 78; UDWR 2009, p. 26). It has rounded dorsal and anal fins, each with eight fin rays (Sigler and Sigler 1996, p. 78). Typically, the northern leatherside chub is bluish above and silver below, but orange to red coloration may occur on some fins (Sigler and Sigler 1996, p. 78). Males also have a golden-red speck at the upper end of the gill opening and between the eyes and the upper jaw (Sigler and Sigler 1996, p. 78).

Two characteristics that distinguish northern and southern leatherside chubs from each other are cranial shape and size-at-age (UDWR 2009, p. 26). Northern leatherside chub have deeper heads with shorter snouts (Johnson *et al.* 2004, p. 850) and are typically 15 percent smaller than southern leatherside chub of the same age, with northern leatherside chub reaching total length of approximately 60 mm (2.4 in.) at age 2 and 71 mm (2.8 in.) at age 3 (Belk *et al.* 2005, pp. 177, 181).

Life History

Before 1995, the life history of the leatherside chub was not well known, with just a few observations of age, growth, or reproduction (Johnson *et al.* 1995, p. 183). Investigations of populations now known as southern leatherside chub demonstrated the species could live up to 8 years and reached sexual maturity at age 2 (Johnson *et al.* 1995, p. 185). Further work corroborated that the majority of northern leatherside chub also mature at age 2, but some not until age 4 (Belk *et al.* 2005, p. 181).

The bulk of our reproductive knowledge about this species comes from the hatchery setting, where successful propagation has occurred. Northern leatherside chub produce translucent, whitish fertilized eggs that are adhesive and can clump together or adhere to substrate (Billman *et al.* 2008a, p. 277). In natural populations, eggs typically hatch in late June (Belk *et al.* 2005, p. 181), but in hatchery conditions, spawning occurs between April and September (Billman *et al.* 2008a, p. 276). In controlled hatchery conditions, eggs hatch between 4 and 6 days to produce fry that still reside in the substrate (Billman *et al.* 2008a, p. 277). Six days after hatching, fry emerge from the substrate, and by 40 days after hatching most have tripled in length to approximately 16 mm (0.63 in.) (Billman *et al.* 2008a, p. 277).

In the hatchery setting, spawning overwhelmingly occurs over cobble substrate (which provides interstitial space for eggs) and in higher velocity flows (which provide oxygen and remove fine sediment) (Billman *et al.* 2008a, p. 277). These conditions indicate main channel riffle or run habitats are likely the natural location of northern leatherside chub spawning.

Northern and southern leatherside chub have similar, relatively broad diets, with aquatic and terrestrial insects and crustaceans accounting for 75 percent of their consumption in one study (Bell and Belk 2004, p. 414). Aquatic and terrestrial insects dominated the autumnal northern leatherside chub diet at the Sulphur Creek sample site (Bell and Belk 2004, p. 414). The species foraged on a wide variety of prey items common to both the substrate and stream drift (Bell and Belk 2004, p. 414). However, it is likely that the species' diet varies throughout the year and at different locations based on available food (Bell and Belk 2004, p. 414). The study results indicate that the species' diet overlaps with other native and nonnative fish, including sculpins (*Cottidae* family), shiners (Cyprinids), and cutthroat (*Oncorhynchus clarkii*) and brown (*Salmo trutta*) trout, suggesting possible competitive interactions (Bell and Belk 2004, p. 414).

Habitat

Northern leatherside chub inhabit small desert streams between elevations of approximately 1,250 to 2,750 meters (m) (4,100 to 9,000 feet (ft)) in the Bear, Snake, and Green River subregions (as defined by the U.S. Geological Survey's (USGS) National Hydrography Dataset (NHD)) (Idaho Department of Fish and Game (IDFG) 2005, p. 1). Streams of this nature encounter extreme seasonal and annual physical conditions because of variation in temperature and precipitation (Wilson and Belk 2001, p. 40). Therefore, northern leatherside chub must endure cold winters and hot summers (water temperature from 0 to 25 °C (32 to 77 °F); high, turbid spring runoff and low, clear summer base flows; and periodic droughts that reduce water in streams (Wilson and Belk 2001, p. 40). It is likely that enduring these variable extreme habitat conditions adapted northern leatherside chub to tolerate varied habitat conditions.

Most habitat descriptions are the result of investigations before leatherside chub was divided into two species, but habitat descriptions for the northern leatherside chub can be evaluated based on their distinct geographic range. Summer water temperature of occupied habitat is reportedly 10 to 23 °C (50 to 73.4 °F), but the current belief is that northern leatherside chub's range is actually restricted to 15.5 to 20 °C (59.9 to 68 °F) (UDWR 2009, p. 27). The species does not persist in lakes or reservoirs (UDWR 2009, p. 27). Northern leatherside chub prefer low water velocities (15 to 23 centimeters per second (cm/s) (0.5 to 0.75 feet per second (fps)), and their probability of occurrence decreases at higher velocities (UDWR 2009, p. 40). Water velocity and temperature generally limit the northern leatherside chub from occupying high headwater streams. Recent habitat investigations show that northern leatherside chub habitat associations are consistent with the results for the southern species (Belk and Wesner 2010, p. 12), allowing us to consider habitat data for southern leatherside chub as generally acceptable for northern leatherside chub.

Distribution

Recent and ongoing investigations continue to revise the current and historical distributions of northern leatherside chub by verifying or invalidating historical specimens, intensely resampling specific stream reaches suspected to harbor the species, and documenting new northern leatherside chub occurrences. For this finding, we completed a white paper summarizing current and historical distributions through fall 2010 (McAbee 2011, entire). We analyzed current and historical range at the subbasin level (otherwise known as 8-digit Hydrologic Unit Code (HUC) in the USGS' NHD or HUC8), and current population locations at the subwatershed level (otherwise known as 12-digit HUC or HUC12). We identified population locations in one to multiple subwatersheds, depending on the perceived interaction between individuals. State wildlife agencies and universities reviewed the document to ensure that it summarized their data collection correctly. Information from our population summary (also known as 'white paper') is used throughout this finding to inform our conclusions (McAbee 2011, entire).

The documented historical range of northern leatherside chub includes portions of the Bear River subregion that drain to the Great Salt Lake, and discontinuous subbasins in the Upper Snake River subregion that eventually drain to the Pacific Ocean (Figure 1; Table 1). It is unclear how this species came to inhabit two presently unconnected hydrologic regions. Past geologic events associated with the draining of Lake Bonneville or the connection of the Bear River to the Snake River as recently as 30,000 years ago (Behnke 1992, p. 134) are likely responsible for the separation (UDWR 2009, p. 25). The range of northern leatherside chub has declined over the past 50 years (Wilson and Belk 2001, p. 36; Johnson *et al.* 2004, pp. 841–842; UDWR 2009, p. 24), and the verified current range of the species is now limited to five of the eight documented historical subbasins (Table 1). However, additional survey efforts are planned or ongoing.

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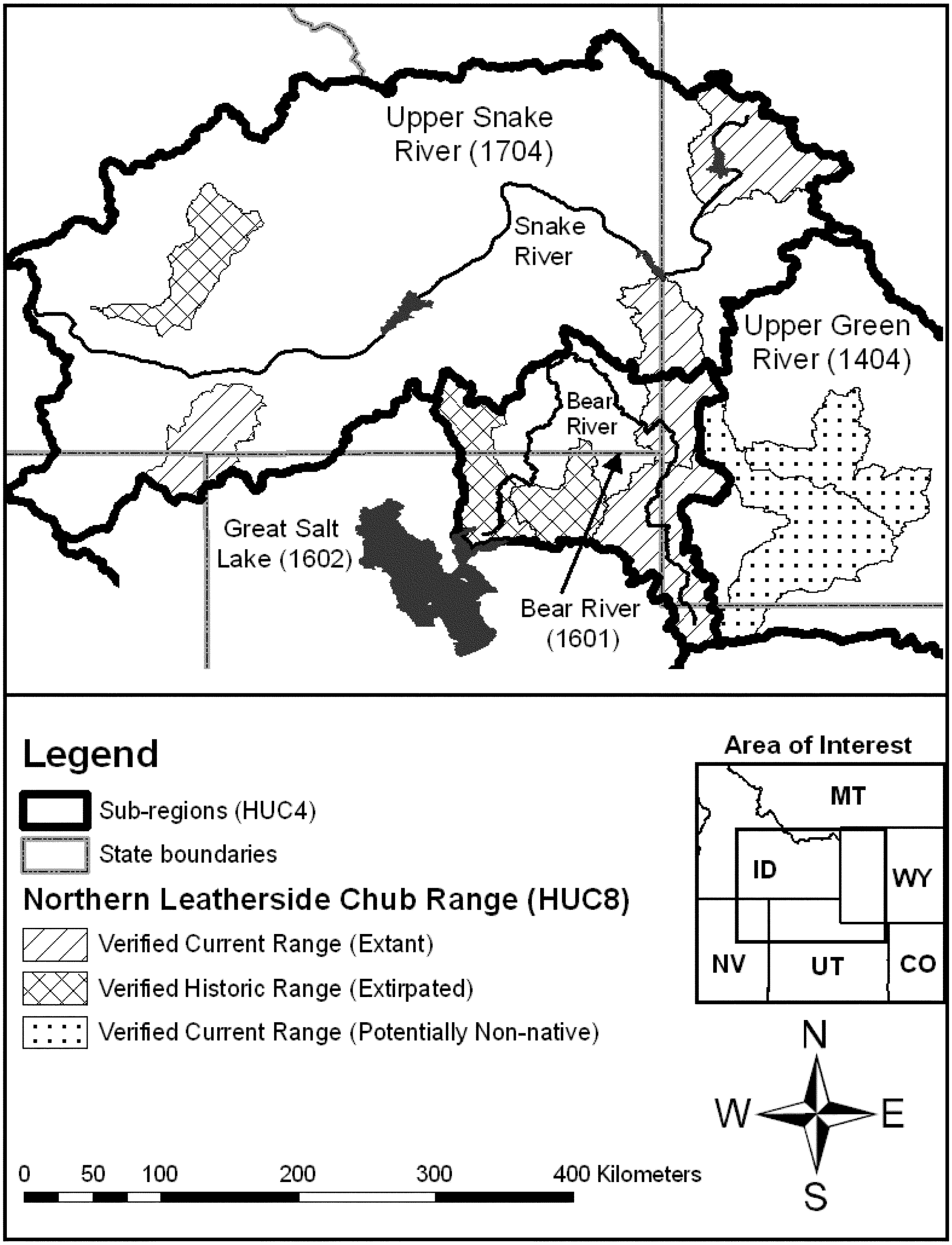

FIGURE 1. Northern leatherside chub range. Subregion names and codes are labeled.

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TABLE 1—DOCUMENTED RANGE OF THE NORTHERN LEATHERSIDE CHUB BY SUBBASIN

NATIONAL HYDROGRAPHY DATASET LOCATIONS			Status
Subregion (code)	Subbasin code and name		
Bear River (1601)	16010101	Upper Bear River	Currently occupied.
	16010102	Central Bear River	
	16010203	Logan River	Historical records only.
	16010204	Lower Bear River	
Upper Snake River (1704)	17040101	Snake Headwaters	Currently occupied.
	17040105	Salt River	
	17040211	Goose Creek	
	17040221	Little Wood River	Historical records only.
Upper Green River (1404)	14040103	Upper Green—Slate Creek	Currently occupied but unconfirmed native range.
	14040107	Blacks Fork	

In addition to the historical range, two populations are now known from the Upper Green River subregion in the Colorado River region (Table 1). It is possible that these occurrences are the result of human introductions. However, genetic analysis is necessary to confirm the origin of these populations, and this information is not yet available. For the purposes of this finding, we acknowledge these populations' conservation value.

Because verifiable, historical records are sparse, we are unable to produce a large-scale historical range boundary with this information. Therefore, we rely on the known, verified collections to analyze the status of the species.

Northern leatherside chub are difficult to identify in the field because they can be confused with other species with similar appearances. Therefore, many collections were incorrectly classified as northern leatherside chub, when in fact they were later verified as Utah chub (*Gila atraria*), speckled dace (*Rhinichthys osculus*), or redside shiner (*Richardsonius balteatus*). Ichthyologists at Brigham Young and Idaho State Universities worked to verify historical records and validate recent collections in order to authenticate data. As a result, many previously accepted collections were refuted, leading to a clearer understanding of the species' range (Northern Leatherside Chub Conservation Team 2010, p. 4). In fact, many subbasins once identified as part of the species' current or historical range are now either questioned or invalidated (Table 2). While we expect that the northern leatherside chub's natural distribution is more continuous than verifiable historical and current data indicate, we have no specific data to describe this range other than what is presented in this finding (Figure 1; Table 3).

TABLE 2—SUSPECTED SUBBASINS THAT ARE NO LONGER CONSIDERED NORTHERN LEATHERSIDE CHUB CURRENT OR HISTORICAL RANGE

NATIONAL HYDROGRAPHY DATASET LOCATIONS			Status
Subregion (code)	Subregion code and name		
Upper Snake River (1704)	17040207	Blackfoot River	Historical specimen incorrectly classified; No verified records.
	17040210	Raft River	Unvouchered historical record not corroborated by recent sampling; No verified records.
	17040213	Salmon Falls Creek	Unvouchered recent record not corroborated by repeated sampling; No verified records.
	17040219	Big Wood River	Unvouchered recent record not corroborated by repeated sampling; No verified records.
Middle Snake (1705)	unknown	Bruneau & Snake Rivers	Historical specimens incorrectly classified; No verified records.
	17050104	Upper Owyhee	Museum records need to be checked.
Great Salt Lake (1602)	16020309	Curlew Valley	Listed in conservation agreement, but no supporting data; No records.

TABLE 3—EXTANT POPULATIONS OF NORTHERN LEATHERSIDE CHUB IN 2010

NATIONAL HYDROGRAPHY DATASET LOCATIONS		POPULATION NAME	STATE
Subregion	Subbasin		
Bear River	Upper Bear	Upper Mill/Deadman Creeks	UT/WY
		Upper Sulphur/La Chapelle Creeks	WY

TABLE 3—EXTANT POPULATIONS OF NORTHERN LEATHERSIDE CHUB IN 2010—Continued

NATIONAL HYDROGRAPHY DATASET LOCATIONS		POPULATION NAME	STATE
Subregion	Subbasin		
		Yellow Creek	UT/WY
		Upper Twin Creek	WY
		Rock Creek	WY
	Central Bear	Dry Fork Smiths Fork	WY
		Muddy Creek	WY
Snake River	Snake Headwaters	Pacific Creek	WY
	Salt River	Jackknife Creek	ID
	Goose Creek	Trapper Creek	ID
		Beaverdam Creek	ID
		Trout Creek	NV/ID
Green River	Upper Green River/Slate Creek	North Fork Slate Creek	WY
	Blacks Fork	Upper Hams Fork	WY

Overall, our identification and confirmation of a northern leatherside population for this finding required the presence of multiple age classes, collection of a dense number of fish (more than five individuals), and documentation of fish collections over multiple years. Meeting these criteria demonstrated to us that northern leatherside chub populations were resident, reproducing, and persisting over time. Within the current range of the northern leatherside chub, we thus delineated 14 extant populations, spread across the Bear (7), Snake (5), and Green (2) River subregions (Table 3). Locations where northern leatherside chub were collected, but were not classified as a population, are detailed in our white paper analysis (McAbee 2011, entire).

Bear River Subregion

The Bear River subregion harbors seven extant populations of northern leatherside chub across two subbasins: Five in the Upper Bear River subbasin and two in the Central Bear River subbasin (Table 3). We are aware of the presence of some individual fish upstream (Hayden and Stillwater Forks) (Nadolski and Thompson 2004, pp. 3, 4, 7; Chase 2010, pers. comm.) and downstream (mainstem Bear River and lower Sulphur Creek) (Wyoming Game and Fish Department (WGFD) 2008, pp. 1, 3; Belk and Wesner 2010, p. 5) of these areas; however, we do not consider these as populations because they do not meet the definition of a population outlined above (specifically presence of multiple age classes and collection of a dense number of fish) due to their low densities and lack of juvenile fish.

In the Upper Bear River subbasin, the Upper Mill/Deadman Creeks and Yellow Creek populations harbor dense, reproducing populations of northern leatherside chub (McKay and Thompson 2010, pp. 4–7). In the Upper Mill/Deadman Creeks population, approximately 1,000 individuals per kilometer are found in Deadman Creek (McKay and Thompson 2010, pp. 6–7) and groups occur downstream in Mill Creek in Utah and Wyoming (Nadolski and Thompson 2004, pp. 3, 7; Belk and Wesner 2010, p. 5). The Yellow Creek population has groups of individuals from the upper reaches in Utah downstream through Wyoming and in Thief Creek, a tributary (Thompson *et al.* 2008, pp. 8–9; Zafft *et al.* 2009, p. 3; Belk and Wesner 2010, p. 5). The Upper Sulphur/La Chapelle Creeks population above Sulphur Creek Reservoir also harbors abundant northern leatherside chubs (Zafft *et al.* 2009, p. 3). This population is likely isolated by the presence of Sulphur Creek Reservoir, which is unsuitable habitat and is stocked with predatory nonnative trout (brown trout before 2000, rainbow trout (*Oncorhynchus mykiss*) currently) (WGFD 2010, pp. 3–6).

Twin Creek, a large tributary to the Bear River in the Upper Bear River subbasin, contains two populations of northern leatherside chub: Rock Creek and Upper Twin Creek. Multiple tributaries to Twin Creek comprise the Upper Twin Creek population, including Clear Creek and the North, East, and South Forks of Twin Creek (Belk and Wesner 2010, p. 5; Colyer and Dahle 2010, p. 5). These populations can presumably interact but are likely isolated from all other populations because sampling has failed to detect downstream emigrants (McKay and Thompson 2010, p. 18).

In the Central Bear River subbasin, the Smiths Fork area harbors at least two large populations: Dry Fork Smiths Fork and Muddy Creek. Both contain hundreds of individuals (Colyer and Dahle 2007, p. 8; Belk and Wesner 2010, p. 5). Individual fish from this population can disperse downstream, but many perish in irrigation canals before reaching the mainstem Bear River (Roberts and Rahel 2008, pp. 951, 955).

Snake River Subregion

The Snake River subregion contains eight subbasins with historical northern leatherside chub observations (UDWR 2009, pp. 44, 48). However, biologists have reexamined museum records, resampled stream reaches with presumed past observations, and refined the identification key for the species. As a result, four of the eight subbasins, the Raft, Big Wood, and Blackfoot Rivers, and Salmon Falls Creek, with past records were downgraded to ''unlikely to have contained or to contain northern leatherside chub'' (Table 2). One subbasin has verified historical records but no current records (Little Wood River), and is thus considered extirpated unless new information is obtained.

The remaining three subbasins with verified current records are Goose Creek, Snake Headwaters, and Salt River (Table 1; McAbee 2011, p. 2). Within the Goose Creek subbasin, we know of three reproducing populations at Trapper, Beaverdam, and Trout Creeks. All three populations have persisted over the past 10 to 15 years (Grunder *et al.* 1987, p. 80; Wilson and Belk 1996, p. 17; Keeley 2010, pp. 3–29). Trapper Creek is isolated from the other two by Oakley Reservoir, but there are no barriers between Trout and Beaverdam Creeks, and the populations likely interact. Collections of single northern leatherside chub individuals in mainstem Goose Creek (Keeley 2010, pp. 24–29) indicate individuals may be dispersing from these two populations. Recent collections of individuals in Pole Creek in the Goose Creek subbasin suggest a population may occur in this tributary as well (Grunder 2010, p. 3). However, no juvenile fish were collected, and this is the first year northern leatherside were documented in this reach (Keeley 2010, pp. 6–11). Although these collections may constitute a colonization event, we do not consider Pole Creek a population in this finding because multiple age classes were not present (demonstrating the area has not shown successful reproduction or recruitment).

The single population in the Snake Headwaters subbasin is Pacific Creek, which has persisted since its discovery in the 1950s (Grand Teton National Park 2009, pp. 1–2; Zafft *et al.* 2009, pp. 2–5). In the Salt River subbasin, a single population is found in Jackknife Creek and its tributaries (Isaak and Hubert 2001, pp. 26–27; Keeley 2010, pp. 45–60). The Pacific Creek population is separated from the Jackknife Creek population by large stream distances and large reservoirs, making individual dispersal between the two populations unlikely. In addition, both the Pacific Creek and Jackknife Creek populations are isolated from the Goose Creek subbasin by upwards of 350 stream-kilometers (km) and many large reservoirs.

Green River Subregion

There are two northern leatherside chub populations in the Green River subregion, one each in the Upper Green River/Slate Creek and Blacks Fork subbasins (Table 3). However, based on the lack of historical collections in the Green River subregion, the lack of a documented natural connection between the Green River subregion and the Bear or Snake River subregions, and the prevalence of human translocations of fish, we determine that it is unlikely that this is the species' native range. The first population was identified in 1988 in North Fork Slate Creek (WGFD 1988 in Zafft *et al.* 2009, p. 2), and represented the first population outside the Bear or Snake River subregions. This population is approximately 30 km (18 mi) east of the Bear and Snake River subregions, making it close enough to be the result of a human introduction. The Upper Hams Fork population was later identified (Wheeler 1997 in Zafft *et al.* 2009, p. 3), and is located approximately 35 km (22 mi) northeast of the North Fork Slate Creek population. In addition, this population is just across the subregion boundary with the Dry Fork Smiths Fork population, making it even more possible that the population is the result of a human introduction. We also are aware of individual fish in the nearby West Fork of the Hams Fork in 2006 (Zafft *et al.* 2009, p. 3), which we include as part of the Upper Hams Fork population because they can interact.

These two populations indicate that northern leatherside chub are persisting in the Green River subregion. Whether these populations are native, or are recent human introductions, has yet to be resolved. Genetic analysis to answer this question is planned for completion in the near future, and will hopefully resolve this question. Until proof can be presented that these populations are not native, their conservation value to the species must be considered.

It is worth noting that genetic analysis of southern leatherside chub collections in the Fremont River (Green River subregion) demonstrated that they were not native, but rather a genetic match to an East Fork Sevier River population (Barrager and Johnson 2010, p. 7). These results show that a successful human translocation of a surrogate species has occurred, and is possible for the northern leatherside chub.

In summary, 14 extant northern leatherside chub populations persist across 3 subregions: 7 populations in the Bear River subregion; 5 populations in the Snake River subregion; and 2 populations in the Green River subregion (Figure 1, Table 1). Land ownership is comprised of privately owned land (31.5 percent in the States of Idaho, Nevada, Utah, and Wyoming), as well as lands managed by BLM (30 percent), NPS (3.5 percent), USFS (30.5 percent), and the States of Wyoming (4.3 percent) and Idaho (0.04 percent) (Service 2011, pp. 11–17). We will investigate threats to these extant populations in the remainder of this finding.

Summary of Information Pertaining to the Five Factors

Section 4 of the Act (16 U.S.C. 1533) and implementing regulations (50 CFR part 424) set forth procedures for adding species to, removing species from, or reclassifying species on the Federal Lists of Endangered and Threatened Wildlife and Plants. Under section 4(a)(1) of the Act, a species may be determined to be endangered or threatened based on any of the following five factors:

(A) The present or threatened destruction, modification, or curtailment of its habitat or range;

(B) Overutilization for commercial, recreational, scientific, or educational purposes;

(C) Disease or predation;

(D) The inadequacy of existing regulatory mechanisms; or

(E) Other natural or manmade factors affecting its continued existence.

In making our 12-month finding on the petition we considered and evaluated the best available scientific and commercial information. Information pertaining to the northern leatherside chub in relation to the five factors provided in section 4(a)(1) of the Act is discussed below.

Factor A. The Present or Threatened Destruction, Modification, or Curtailment of Its Habitat or Range

The following potential threats that may affect the habitat or range of northern leatherside chub are discussed in this section, including: (1) Livestock grazing; (2) oil and gas development; (3) mining; (4) water development; (5) water quality; and (6) fragmentation and isolation of existing populations.

Livestock Grazing

Livestock presence generally disturbs streamside and instream habitats, particularly in the arid west where riparian and stream habitats are fragile ecosystems (Kauffman and Krueger 1984, p. 431; Helfman 2007, p. 102). Livestock grazing is especially detrimental to riparian habitats because livestock spend disproportionately more time near water (Helfman 2007, p. 102). They typically eat and trample riparian vegetation and compact soil, which leads to impacts that include increased sediment inputs from runoff, nutrient loading from livestock waste, higher stream temperatures from lack of vegetation shading, and reduction in invertebrate abundance (Kauffman and Krueger 1984, p. 432; Wohl and Carline 1996, p. 264; Stoddard *et al.* 2005, p. 8). These impacts combine to degrade habitats for many fish species, especially species requiring cool, clear water and gravel substrate, such as salmonids (Helfman 2007, p. 34).

However, some species, such as the northern leatherside chub, can tolerate certain habitat changes and persist despite disturbed conditions. Increased sediment may alter a fish community and allow for domination by species that thrive or contend well with sandy substrates (Sutherland *et al.* 2002, pp. 1801–1802) (see Water Quality section for specific discussion of sedimentation and northern leatherside chub). Similarly, increased water temperature also may alter the distribution of species, forcing out cold-water species, and allowing for warm-water species to enter a habitat (Field *et al.* 2007, p. 631). Northern leatherside chub apparently can tolerate certain disturbances, largely because they can survive extreme environmental conditions to which they are evolutionarily adapted (Belk and Johnson 2007, p. 70), such as high water temperatures (Isaak and Hubert 2001, p. 27; Wilson and Belk 2001, p. 39), with a critical thermal maximum of approximately 30 °C (86 °F) (Billman *et al.* 2008b, p. 463) and persist in large numbers in areas deemed degraded (Muddy Creek and Upper Twin Creek). However, we do not have specific data indicating their tolerances to all water quality conditions. While habitats impacted by grazing may not be preferred, populations of northern leatherside chub persist in locations deemed degraded and impaired.

For example, in the Bear River subregion, the Upper Twin Creek population persists even though overgrazing has reduced the riparian vegetation cover (Colyer and Dahle 2010, pp. 16, 19) to the point that the streams are classified as degraded (BLM 2011, entire). In the same subregion, Muddy Creek is another example of a dense northern leatherside chub population that persists (Colyer and Dahle 2007, Table 6) despite altered conditions from overgrazing that result in a very wide, shallow channel and degraded riparian habitats (BLM 1999, p. 7; BLM 2007a, pp. 1–2; Prichard 1998, p. 8; BLM 2005, p. 5). In the Snake River subregion, populations persist in Beaverdam and Trapper Creeks although the water quality in both streams is impaired, most likely as the result of overgrazing (Lay 2003, pp. 69–70, 125). However, it is worth noting that impacts from grazing affect Beaverdam and Trapper Creeks in qualitatively different ways (high suspended sediment) than Muddy and Upper Twin Creeks (reduced riparian cover).

Data indicate that some level of livestock grazing occurs across the entire range of the northern leatherside chub and near all existing populations (Service 2011, pp. 18–24). Because of the prevalence of grazing across the western United States, the species will likely encounter livestock grazing effects. However, we expect effects from livestock grazing will decrease over time on Federally managed lands as management agencies address livestock grazing practices. For example, the U.S. Forest Service (USFS) recently implemented changes in the grazing management on the Goose Creek grazing allotment that occurs in the upstream portions of Beaverdam and Trout Creeks (Northern Leatherside Chub Conservation Team 2011, p. 3). On a broader scale, Bureau of Land Management (BLM) guidelines in Idaho (BLM 1997, p. 4, Standard #2), Wyoming (BLM 2007c, p. 1, Standard #2), Utah (BLM 2009, p. 1, Standard #1b), and Nevada (BLM 2007b, p. 1, Standard #2) require all streams to have riparian health consistent with natural, functional habitats, indicating that grazing impacts will be improving on BLM lands. Upstream land ownership for all but three occupied sub-watersheds (11 of 14) is over 50 percent federally owned, demonstrating the importance of Federal land management for northern leatherside chub (see detailed discussion of land ownership under Factor D below).

In summary, there is no apparent indication that grazed areas are negatively impacting existing populations of northern leatherside, although grazing has likely affected water quality (discussed later). Populations of northern leatherside chub occur in a wide variety of habitat conditions, from unaltered locations to those with heavily altered riparian conditions impacted by livestock grazing practices. In fact, some of the densest populations occur in areas that are heavily grazed. Also, there is evidence to indicate that livestock grazing impacts will be declining in the future, as more sustainable rangeland management practices are applied. We found no information that grazing may act on this species to the point that the species itself may be at risk, nor is it likely to become so.

Oil and Gas Development

Oil and gas exploration and development can impact fish habitats, primarily through degraded watershed health. Increased land disturbance from roads and pads reduce water quality because of increased sediment loads (WGFD 2004, p. 25; Matherne 2006, p. 1). Road culverts also can fragment fish habitats if they are designed in a way that impedes fish migration (Aedo *et al.* 2009, p. 2). Drilling operations often require water depletions from local water sources and can result in accidental spills of contaminants into fish habitat (Stalfort 1998, p. ES–2; Etkin 2009, pp. 35–42). Accumulations of contaminants, such as hydrocarbons and produced water (water locked away in formation with oil and gas that is typically not suitable for human or wildlife use), can result in lethal or sublethal impacts across the entire aquatic food chain, including sensitive fish species (Stalfort 1998, Section 4). Water depletions can reduce or eliminate aquatic habitat, creating multiple negative effects (see Water Development, below).

To analyze the potential impacts from oil and gas development, we investigated past and present levels of development and the potential for future development in occupied populations. We summarized the analysis in an internal white paper (Hotze 2011, pp. 1–8) and reference the results throughout this finding. Data sources for the investigation included Bureau of Land Management Resource Management Plans (BLM 1985, entire; BLM 2010, entire); State databases of oil and gas development (Hess *et al.* 2008, entire; Utah Division of Oil, Gas, and Mining 2009, entire; Wyoming Oil and Gas Conservation Commission 2009, entire; State of Idaho 2011, entire); and energy development maps (Garside and Hess 2007, map; Energy Information Administration (EIA) 2009a, map; EIA 2009b, map; EIA 2011, entire).

TABLE 4—SUMMARY OF OIL AND GAS DEVELOPMENT IN EXTANT NORTHERN LEATHERSIDE CHUB POPULATIONS

National hydrography dataset locations		Population name	State	Active oil & gas wells (inactive)	Overlap with known coalbed methane reserves (%)
Subregion	Subbasin				
Bear River	Upper Bear	Upper Mill/Deadman Creeks	UT/WY	0 (6)	4
		Upper Sulphur/La Chapelle Creeks.	WY	2 (1)	47
		Yellow Creek	UT/WY	28 (63)	25
		Upper Twin Creek	WY	0 (0)	9

TABLE 4—SUMMARY OF OIL AND GAS DEVELOPMENT IN EXTANT NORTHERN LEATHERSIDE CHUB POPULATIONS—Continued

National hydrography dataset locations		Population name	State	Active oil & gas wells (inactive)	Overlap with known coalbed methane reserves (%)
Subregion	Subbasin				
		Rock Creek	WY	0 (1)	131
	Central Bear	Dry Fork Smiths Fork	WY	0 (0)	0.1
		Muddy Creek	WY	0 (0)	0
Snake River	Snake Headwaters	Pacific Creek	WY	0 (0)	0
	Salt River	Jackknife Creek	ID	0 (0)	16.6
	Goose Creek	Trapper Creek	ID	0 (0)	0
		Beaverdam Creek	ID	0 (0)	0
		Trout Creek	NV/ID	0 (0)	0
Green River	Upper Green River/Slate Creek	North Fork Slate Creek	WY	0 (5)	32
	Blacks Fork	Upper Hams Fork	WY	0 (0)	0

We found that throughout the range of northern leatherside chub, neither active development nor potential for future development of oil and gas are common, with both being limited to one localized area, the Yellow Creek population in the Bear River subregion (Table 4) (Hotze 2011, pp. 1–8). A quarter of the Yellow Creek population overlaps with proven Federal oil and gas reserves, mostly in the western and northern portions of the subwatershed (EIA 2009a, map; Hotze 2011, p. 5). Current and past well activity follow this overlap, with 63 inactive and 28 active wells in the population's subwatershed, mainly near the occupied areas of Thief Creek and lower Yellow Creek in Wyoming (Hotze 2011, p. 2). No development activity has occurred in the upstream portions of Yellow Creek, which contain high densities of northern leatherside chub, and no proven Federal oil and gas reserves occur there. A quarter of the Yellow Creek population overlaps with coalbed methane reserves, in the eastern-central portion in Wyoming, suggesting the potential for development (Hotze 2011, p. 7).

The populations in the northern portions of the Bear River subregion have seen little past or current development and have a low probability of future development. The Twin Fork drainage has only one inactive well across the Rock and Upper Twin Creek populations (Hotze 2011, p. 2). A small portion (less than 1 percent) of the Rock Creek population overlaps with the Collett Creek field, which contains proven Federal oil and gas reserves (Hotze 2011, pp. 4–5). The Smiths Fork drainage is north of the Wyoming Thrust Belt (an optimal geologic formation for retrieving oil and gas resources), so development of oil reserves has not historically occurred in the Muddy Creek and Dry Fork Smiths Fork populations, and is not likely to occur in the future (Hotze 2011, p. 2). Similarly, there is very little overlap between these two populations and known coalbed reserves (less than 1 percent of the Dry Fork Smiths Fork population) (Hotze 2011, p. 7), making it unlikely that coalbed methane development will take place in these populations.

In the remainder of the Bear River subregion, past and current resource development is rare, but resource potential exists. The Upper Sulphur/La Chapelle Creeks population has only one inactive and two active wells, but half of the population area overlaps with coalbed methane reserves (Hotze 2011, pp. 2, 7). However, the area has a low potential for resource extraction demonstrated by the low presence of current or past wells and the distance to the closest producing well. The Upper Mill/Deadman Creeks population has only six inactive wells, all in the Utah portion of the population's subwatershed (Hotze 2011, p. 2). Less than 5 percent of the Upper Mill/Deadman Creeks population overlaps with coalbed methane reserves, all in the most downstream reaches that do not contain northern leatherside chub (Hotze 2011, p. 7).

The Snake River subregion populations occur in areas that do not have active development and are characterized as low potential for future development (Hotze 2011, pp. 1–2). Currently, all populations in the Goose Creek subbasin (Trout, Trapper, and Beaverdam Creeks) are in areas open for oil and gas leasing, but there are no producing wells in either the Idaho or Nevada portions (Hotze 2011, p. 2). Further east, there is potential for development of the Idaho-Wyoming Thrust Belt in the Jackknife Creek population, but the probability of discovering and developing oil in this area is considered low by BLM (BLM 2010, p. Q–1). No wells are currently found in the Jackknife Creek population (Hotze 2011, p. 2). Finally, the Pacific Creek population may overlap with the Jackson Hole coalbed methane field, but management by Grand Teton National Park makes it unlikely that development of these resources will take place (Hotze 2011, p. 2).

In the portions of the Green River subregion occupied by northern leatherside chub, there is little active or historical development of any kind and minor potential for future development exists, chiefly from coalbed methane reserves. The Upper Hams Fork is outside of any known coalbed reserves, the population is north of the Wyoming Thrust Belt and west of the Wyoming Overthrust coalbed reserves (Hotze 2011, pp. 2, 7). As a result, it has no active or inactive wells within its boundary, and we consider future development potential in this population negligible (Hotze 2011, p. 2). The North Fork Slate Creek population has only five inactive wells within its boundary, but overlaps with the Wyoming Overthrust coalbed reserves in the upstream third of the population (Hotze 2011, pp. 2, 7). It is possible that development could occur in this population, but we have no data to indicate that development is planned or imminent. Also, without environmental planning for this development, we cannot say what impacts the development would have on northern leatherside chub.

To summarize, past, present, and future oil and gas development is likely to impact one population of northern leatherside chub, Yellow Creek in the Bear River subregion, and only in the downstream half. Only two populations overlay with proven Federal oil and gas reserves, Yellow and Rock Creeks (Table 4). The Rock Creek overlap is insignificant, accounting for less than 1 percent of the population's subwatershed. However, the Yellow

Creek overlap is sizable, at approximately a quarter of the population's subwatershed. Correspondingly, only Yellow Creek has measurable levels of current energy development at a moderate scale. Because the impacts to Yellow Creek are downstream of a large portion of the occupied area within the population boundary, we find oil and gas development does not threaten the persistence of the Yellow Creek population. Although some resource potential is found throughout the range of the species, future development is unlikely to occur or impact all but one population (Yellow Creek). Oil and gas development impacts only a small portion of the species' total range, and the impacted population will likely persist in upstream reaches. We found no information that oil and gas development may act on this species to the point that the species itself may be at risk, nor is it likely to become so.

Mining

Hardrock mining for such materials as gold, copper, iron ore, uranium, and others is the most common mining activity in the western United States (Trout Unlimited 2011, p. 1). Underground and surface mining activities have the potential to negatively affect fish species by releasing solid wastes and contaminated mine water (Helfman 2007, pp. 160–161; Trout Unlimited 2011, p. 1).

Solid waste from mining includes overburden, which is the topsoil and surface rock that is above a mineral deposit; waste rock, which is the low grade ore that surrounds a mineral deposit; and tailings, which are the fine-grained materials that are left over from the processing of raw ore (Trout Unlimited 2011, p. 1). Abandoned and currently operating mine sites can impact downstream fish species from the sedimentation that results from erosion of waste rock (Helfman 2007, pp. 112, 113) (see Water Quality section for specific discussion of sedmentation and northern leatherside chub).

Contaminated mine water is the ground or surface water that accumulates and is discharged from a mine or its associated waste rock piles (Trout Unlimited 2011, p. 1). This water can cause deleterious effects to fishes via acidification and heavy metal contamination (Helfman 2007, pp. 160–161, 168–169). Stream acidification results from drainage of waters from mines or their waste rock by-products. This water is highly toxic because the associated low pH harms fish respiratory function and can impact reproduction rates and rearing outcomes (Helfman 2007, p. 159). Low pH in aquatic systems also can negatively affect aquatic plants and macroinvertebrates and thereby reduce food sources and habitat for fish (Helfman 2007, pp. 160–161; Trout Unlimited 2011, p. 1). Heavy metal contamination of aquatic habitats also can result from mine water that is discharged from mines or that infiltrates and then runs out of waste rock or tailings piles. Heavy metals such as lead, copper, zinc, cadmium, mercury, aluminum, iron, manganese, and selenium can be toxic to fishes at low concentrations and can ultimately interfere with embryonic development, digestion, respiration, general growth, and survival (Helfman 2007, pp. 160, 161; Trout Unlimited 2011, p. 1).

We assessed mining activity within the range of northern leatherside chub by reviewing mining location data as reported by State agencies and in GeoCommunicator, the publication Web site for the National Integrated Land System as operated by a joint venture between the BLM and USFS (*http://www.Geocommunicator.gov/GeoComm,* Mining Claims). This information shows that uranium, coal, and non-coal (all other mine types) were prospected for in much of the northern leatherside chub range (Service 2011, pp. 25–32). However, the majority of these mines or prospects are historical and are no longer in operation (Service 2011, pp. 25–32).

In the Bear River subregion, there are no abandoned mines, active mines, or mining claims in the Upper Mill/Deadman Creeks, Upper Sulphur/La Chapelle Creeks, Yellow Creek, or Muddy Creek populations (Service 2011, pp. 28, 30). In the Rock Creek drainage, there are 11 quarter sections with 1 to 5 mining claims each; however, these are located downstream of northern leatherside chub occupied habitat and are not being actively developed (Service 2011, p. 29). The Upper Twin Creek population has one abandoned mine about 2 miles (mi) upstream of occupied habitat on North Fork Twin Creek, and approximately four abandoned mines upstream of occupied habitat on East Fork Twin Creek (Service 2011, p. 29). Also, a small portion of the headwaters of the Upper Twin Creek population is under an active coal lease; however, the active mining associated with this lease is found on the other side of the watershed boundary, meaning impacts will not affect northern leatherside chub (WSGS 2009, map). We have no information to indicate that any of these abandoned mines are having an effect on adjacent northern leatherside chub in the Upper Twin Creek population. In the Dry Fork Smiths Fork population, there are eight quarter sections with one to five mining claims; however, these are located primarily downstream of northern leatherside chub occupied habitat, are not developed, and thus should not have an effect on occupied habitat (Service 2011, p. 30).

In the Snake River subregion, there are no abandoned mines, active mines, or mining claims within northern leatherside chub habitats in the Trout or Jackknife Creek populations (Service 2011, pp. 25, 26). The Trapper Creek and Beaverdam Creek populations have several abandoned mines of lignite and uranium prospects/deposits that are adjacent to northern leatherside chub occupied habitat (about four to five sites in each drainage) (Service 2011, p. 25). Because prospects and identified deposits usually involve a small disturbance such as a shallow hole or a short adit (an entrance to an underground mine which is horizontal or nearly horizontal), we determine these features are having negligible impact on northern leatherside chub occupied habitat. In the Pacific Creek population where northern leatherside chub are found, there are 11 quarter sections with 1 to 5 mining claims each (Service 2011, p. 27). These mining claims occur upstream of northern leatherside chub occupied habitat; these claims are not developed, and we have no information to suggest that these will be developed. At this time we have no information to suggest that any of these abandoned mines or mining claims are having a significant effect on adjacent northern leatherside chub at an individual or population level.

In the Green River subregion, neither the Slate Creek nor the Upper Hams Fork populations have abandoned mines, active mines, or mining claims (Service 2011, pp. 31–32). Thus, there are no effects from mining on northern leatherside chub populations in these areas.

In summary, recent examination of mining activity in northern leatherside chub habitat has determined that mining-related impacts are limited. Mining was historically prevalent in occupied portions of the Bear and Snake subregions, but largely absent in occupied portions of the Green River subregion. Some mines do still operate in northern leatherside chub populations. However, we have no information at this time to suggest that mining activities are having an effect on water resources or habitat of northern leatherside chub. We found no information that mining activities may act on this species to the point that the species itself may be at risk, nor is it likely to become so.

Water Development

Water development in western North America has the potential to impact native fish species by degrading aquatic habitats and altering natural ecological mechanisms (Minckley and Douglas 1991, p. 15; Naiman *et al.* 2002, p. 455). Water development can affect aquatic species through desiccation (drying that results in loss of habitat), reduction in available habitat from reduced flows, reduced population connectivity, and decreases in water quality (e.g., higher water temperatures in summer months because of lower water volume or increased concentration of pollutants). In addition, water diversion structures often entrain (pull in and trap) fish into canal systems along with irrigation water, placing fish in lethal habitats because water supplies are typically shut off at the end of the irrigation season (Roberts and Rahel 2008, p. 951).

The development of water resources in the Bear, Snake, and Green River subregions has led to the conversion of some northern leatherside chub stream habitats into seasonally dewatered channels (complete absence of flowing water) (Nadolski and Thompson 2004, p. 4; Thompson *et al.* 2008, p. 20; McKay *et al.* 2009, p. iv; Yarbrough 2011, pers. comm.), representing a complete loss of habitat in some areas. In the following analysis, we consider the impact of complete dewatering and entrainment on each northern leatherside chub population. We do not consider impacts of reduced water volume for each population because leatherside chub have a broad tolerance of extreme environmental conditions (Belk and Johnson 2007, p. 70) and have persisted in a number of locations where low water levels occurred. Leatherside chub are adapted to periodic low water conditions and can survive in remnant pools for several weeks after the water flow is completely eliminated (Belk and Johnson 2007, p. 70). Therefore, complete dewatering represents the highest risk for mortality of individuals and represents the primary barrier for movement. Similarly, entrainment creates the risk of direct mortality, as entrained fish, especially northern leatherside chub, are not expected to survive in irrigation canals.

Dewatering of Streams

We determined occurrences and temporal extent of recent dewatering events in occupied populations through agency reports and expert accounts. In recent, recorded history, no known dewatering events occurred near 8 of the 14 populations: Upper Mill/Deadman Creeks (Thompson 2011, pers. comm.); Dry Fork Smiths Fork (BLM 2002, p. B–7); Muddy Creek (Henderson 2011, pers. comm.); Pacific Creek (Clark *et al.* 2004, pp. 26–29; O'Ney 2011, pers. comm.); Jackknife Creek (Lyman 2011, pers. comm.); Trapper Creek (Bisson 2011, pers. comm.); Trout Creek (Lay 2003, p. 8); and Upper Hams Fork (Yarbrough 2011, pers. comm.). As a result, we determine that these populations are not threatened by current water development.

However, six northern leatherside populations did experience complete dewatering events in areas adjacent to or within their known habitat and we further analyzed effects to these populations (Table 5). All dewatering events are seasonal in nature and occur in mid to late summer (Nadolski and Thompson 2004, p. 4; Thompson *et al.* 2008, p. 20; McKay *et al.* 2009, pp. 20–21), when dry weather and irrigation pressures are highest. We will address dewatering conditions and the population response for five population areas (two populations, Rock and Upper Twin Creek, are experiencing the same nearby dewatering, so will be considered together): (1) Upper Sulphur/La Chapelle Creeks; (2) Yellow Creek; (3) Rock and Upper Twin Creeks, all in the Bear River subregion; (4) Beaverdam Creek in the Snake River subregion; and (5) North Fork Slate Creek in the Green River subregion.

TABLE 5—NORTHERN LEATHERSIDE CHUB POPULATIONS THAT HAVE ENCOUNTERED PAST DEWATERING EVENTS AND THE NATURE OF THESE EVENTS

National hydrography dataset locations		Population	Nature of dewatering event
Subregion	Subbasin		
Bear River	Upper Bear	Upper Sulphur/La Chapelle Creeks.	Dewatering upstream in headwaters & downstream near reservoir; No threat to population.
		Yellow Creek	In downstream portion; Reproduction still occurs locally & upstream portions unaffected; No threat to population.
		Upper Twin Creek Rock Creek	Downstream of both populations; Does not prevent movement between populations; No threat to populations.
Snake River	Goose Creek	Beaverdam Creek	In downstream portion; Population sustains in perennial portion but becomes isolated; No threat to population.
Green River	Slate Creek	North Fork Slate Creek	Downstream portions are intermittent but local areas perennial; No threat to population.

Irrigation demands periodically dewater portions of Upper Sulphur Creek directly upstream of Sulphur Reservoir (Amadio 2011, pers. comm.), possibly preventing the migration of northern leatherside chub between the two occupied areas of the Upper Sulphur/La Chapelle Creeks population in the Bear River subregion. Additionally, headwater portions of this area were dewatered in Utah in 2007 (Webber 2008, p. 21). However, neither of the dewatered areas are the primary occupied portion of the population, as northern leatherside chub occupy portions of Sulphur and La Chapelle Creek in Wyoming upstream of Sulphur Creek Reservoir, and also downstream of the Utah border. Because dewatering events do not impact habitats occupied by the population, we conclude dewatering is not a threat to this population.

The lower reaches of Yellow Creek (Bear River subregion) have low flows (Thompson *et al.* 2008, p. 21) or are completely dewatered (Nadolski and Thompson 2004, p. 4) in the summer months. However, successful reproduction was evident in nearby upstream portions of Yellow Creek in 2002, 2005, and 2008 (Thompson *et al.*

2008, p. 11). Upper portions of Yellow Creek (from Utah-Wyoming border to the headwaters) retain water throughout the year and are occupied by a healthy northern leatherside chub community (Thompson *et al.* 2008, p. 21). The upper portions of Yellow Creek likely act as a source population to lower Yellow Creek reaches in years of extreme low water, and for this reason dewatering is not a threat to this population.

Lower portions of mainstem Twin Creek in the Bear River subregion are completely dewatered by an irrigation diversion 6.75 km (4.2 mi) upstream of the Utah-Wyoming border during most of the irrigation season (Thompson *et al.* 2008, p. 20). However, northern leatherside chub are present in several locations upstream of this diversion, including two extant populations—the Rock and Upper Twin Creek populations (Belk and Wesner 2010, p. 5; Colyer and Dahle 2010, p. 5). Northern leatherside chub move through the lower mainstem Twin Creek (downstream of the diversion) to the mainstem Bear River during portions of the year when there is water (Thompson *et al.* 2008, p. 20), demonstrating the connectivity of these rivers. Because of the connection between upstream and downstream communities within this population, and because the upstream communities of Rock and Clear Creeks are perennial streams (Wyoming Department of Environmental Quality 2010, p. 15), dewatering is not a threat to these populations.

Beaverdam Creek in the Snake River subregion begins at the confluence of Left Hand Fork Beaverdam Creek and Right Hand Fork Beaverdam Creek, with flow being supported by approximately seven intermittent or ephemeral streams (Lay 2003, p. 99). Lower portions of Beaverdam Creek are commonly dewatered, leading the Idaho Department of Environmental Quality (IDEQ) to identify the lower two-thirds of Beaverdam Creek as intermittent (Lay 2003, p. 99). These sections include portions near the Emery Ranch and the lowest 3 to 5 km (1.9 to 3.1 mi) of stream from Emery Ranch to Goose Creek (Lay 2003, p. 99). However, Upper Beaverdam Creek maintains high enough year-round flow to sustain a cutthroat trout population (Lay 2003, p. 99). Northern leatherside chub populations also are located in the perennial waters of upper Beaverdam Creek. The effect of ephemeral dewatering in lower Beaverdam Creek on northern leatherside chub is to seasonally isolate this population from other Goose Creek populations in all but the wettest conditions. Because this population is reproducing and self-sustaining, we conclude that seasonal dewatering is not currently a threat to the population.

Portions of Slate Creek in the Green River subregion and its tributaries are intermittent (Yarbrough 2011, pers. comm.). The South and Middle Forks of Slate Creek were completely dewatered in July 2003 (WGFD 2009, p. 4). We have little information regarding the demography of this population, except that several age classes were found in mainstem Slate Creek and North Fork of Slate Creek during 2003 (WGFD 2009, p. 5). This suggests reproduction and juvenile recruitment is not impacted by dewatering in adjacent streams. There is no record of dewatering in the North Fork or mainstem of Slate Creek where northern leatherside chub are found. Because dewatering occurs downstream of occupied habitat and reproduction is occurring, we do not consider dewatering a threat to this population.

While the preceding analysis considered past and current water development, future water development across the range of northern leatherside chub may alter the level of impacts. Northern leatherside chub-occupied subwatersheds in Utah and Idaho are closed to new water appropriations for any significant consumptive use such as large-scale irrigation (Dean 2011, pers. comm.; Jordan 2011, pers. comm.). In contrast, subwatersheds occupied by northern leatherside chub in Nevada and Wyoming are still open to new water appropriations (Randall 2011, pers. comm.; Jacobs and Brosz 2000, p. 7). However, we expect minimal future water development near the only population in Nevada (Trout Creek) because of the low human population density in the area and because we are not aware of any new water-intensive land use planned for the area (Randall 2011, pers. comm.). Although irrigated agriculture production is the largest water use in Wyoming's three northern leatherside chub occupied subbasins (Schroeder and Hinckley 2007, p. 5–2), agricultural water use is expected to increase at most 9.2, 5.6, and 5.2 percent for the Green, Bear, and Snake subregions in Wyoming, respectively, between 2007 and 2037 (Schroeder and Hinckley 2007, pp. 6–2—6–4). We consider these small increases and conclude that this full development would not be a threat to northern leatherside chub in Wyoming. Because predictions for future water development for occupied subbasins indicate water development is either prohibited or minimal, the available information indicates that the northern leatherside chub is not threatened throughout all of its range by water development, nor is it likely to become so.

In summary, while northern leatherside chub are adapted to endure short-term low water conditions, complete dewatering events can result in the temporary, seasonal loss of northern leatherside chub habitat. However, in all of the dewatering events described above, individual fish are either not locally impacted by dewatering or are able to move to nearby perennial reaches during the dewatered period. Additionally, future water development is closed in Utah and Idaho, unlikely in Nevada, and small-scale in Wyoming. We found no information that dewatering may act on this species to the point that the species itself may be at risk, nor is it likely to become so.

Entrainment

Fish encountering unscreened irrigation intake structures are often injured or killed, primarily through entrainment, the process by which aquatic organisms are diverted into irrigation structures (Zydlewski and Johnson 2002, p. 1276; Gale *et al.* 2008, p. 1541). Entrainment into irrigation canals is considered a major source of mortality for fish populations in the western United States because individual fish entering canal systems typically cannot escape back into stream habitat (Carlson and Rahel 2007, p. 1335; Roberts and Rahel 2008, p. 951). Near 100 percent mortality is expected once an individual enters an irrigation canal structure because of the numerous unnatural conditions in the canals. Individuals entrained into canals are exposed to higher water temperatures and non-natural substrate (often concrete), while also becoming easier prey for predatory birds and mammals. Those fish that survive for long periods ultimately encounter the end of the irrigation season, when water is often shut off from the canals (Roberts and Rahel 2008, p. 954), trapping individual fish in dewatered, lethal conditions. Screening intake structures is the most common method to minimize entrainment of fish (Zydlewski and Johnson 2002, p. 1276; Moyle and Israel 2005, p. 20; Gale *et al.* 2008, p. 1541). However, screening facilities must be designed to meet individual criteria at each location, taking into account the sizes and swimming abilities of the fish species that will encounter the structure.

Because they are small minnows with weak swimming abilities, all northern leatherside chub entrained into canals are expected to die (Roberts and Rahel

2008, p. 957). For example, irrigation facilities in the Smiths Fork River entrained an estimated 195 northern leatherside chub downstream of two populations, Dry Fork Smiths Fork and Muddy Creek (Roberts and Rahel 2008, p. 957). Similarly, a large irrigation structure in lower mainstem Twin Creek entrained native fish species, including northern leatherside chub, downstream of two populations, Upper Twin and Rock Creeks (Colyer and Dahle 2010, p. 5). These data show that where northern leatherside encounter irrigation structures, they are entrained.

Across the range of northern leatherside chub, irrigation is a common practice. However, besides the large network of irrigation intakes in the Smiths Fork (Carlson and Rahel 2007, p. 1336) and Twin Creek drainages (Colyer and Dahle 2010, p. 6), we know of no other documented instances of entrainment. In addition, many of the diversions that could entrain northern leatherside chub in the Twin Creek drainage were updated with screened, fish-friendly structures by Trout Unlimited over the past few years (Colyer and Dahle 2010, p. 6), thereby greatly reducing their threat to northern leatherside chub.

Based on the data from the Smiths Fork and Twin Creek drainages, we conclude entrainment into canals is likely preferentially targeting migrating individuals because entrainment is occurring primarily downstream of populations. This makes entrainment more of an agent of fragmentation than a threat to extant populations. We expect that when irrigation diversions are not taking the entire water supply from the stream, an unknown portion of individuals can bypass the structure, likely providing enough population interaction (as shown in other species: Hanson 2001, p. 331; Gale *et al.* 2008, p. 1546). For example, because the documented entrainment in the Smiths Fork drainage is downstream of both populations, individuals from the Dry Fork Smiths Fork population could reach the Muddy Creek population without encountering the entraining structure.

In summary, while the potential impact of entrainment occurs across the species' range (anywhere an unscreened diversion exists), it has been documented downstream of only four populations, all in the Bear River subregion. While the loss of emigrating individuals is important to adequate species metapopulation dynamics, entrainment likely affects only a small fraction of migrating individuals and does not impact resident individuals in the core population areas. Entrainment may reduce the ability of northern leatherside chub to migrate between populations, but without an irrigation structure diverting the entire stream, some individuals should be able to bypass structures. We found no information that entrainment may act on this species to the point that the species itself may be at risk, nor is it likely to become so.

Summary of Water Development

We determined that current levels of water development—entrainment and dewatering—impact only a small portion of the extant populations of northern leatherside chub, and primarily occur downstream of the inhabited population areas. Because these factors are not occurring near the existing core areas, they are largely impacting migrating individuals and reducing population connectivity, not imperiling overall population persistence. Future water development is closed in Utah and Idaho, unlikely in Nevada, and small-scale in Wyoming. We found no information that water development may act on this species to the point that the species itself may be at risk, nor is it likely to become so.

Water Quality

Water pollution and habitat degradation impair the ability of aquatic systems to support life for at least 34 percent of the river and stream habitats in the United States (Environmental Protection Agency (EPA) 2002, p. 12). Examples of pollutants of concern for aquatic systems include heavy metals, biocides, endocrine disrupters, acid rain, sediments, dissolved solids, and excess nutrients (Stoddard *et al.* 2005, p. 8; Helfman 2007, p. 158). The effects of pollution on fish can include immediate death or long-term disabilities, such as increased incidence of disease, abnormalities, and altered behavioral or metabolic responses (Helfman 2007, p. 160).

Waters that do not meet water-quality standards due to point and non-point sources of pollution are listed on the EPA's 303(d) list of impaired water bodies. Therefore, we used the EPA 303(d) list of impaired waters (see discussion under Factor D) to assist in determining if pollution or degraded water quality is a threat to northern leatherside chub (EPA 2010, pp. 1–2). Because the EPA's water quality standards are thought to be protective of aquatic life, we determined that a stream not listed as impaired on the EPA 303(d) list did not have a high enough magnitude of pollution impacts to warrant further analysis. States must submit to the EPA a 303(d) list (water-quality-limited waters) and a 305(b) report (status of the State's waters) every 2 years, making our analysis up-to-date. Of the 14 northern leatherside populations, 2 populations that occur in the Goose Creek subbasin (Trapper and Beaverdam Creeks) are found in streams listed in Idaho's most recent 2008 integrated 303(d)/305(b) report. Trapper Creek's water quality is listed as impaired from nutrients (defined by Idaho as including phosphorus, nitrogen, and organic compounds), specifically total phosphorous, sediment, and dissolved oxygen (IDEQ 2010, p. vii). Beaverdam Creek is impaired by nutrients (total phosphorous), bacteria, temperature, sediment, and dissolved oxygen (Lay 2003, p. xxii). Impaired water-quality conditions in both creeks may be the result of livestock grazing effects (Lay 2003, pp. 69–70, 125).

These impairments can have varying impacts to fish and stream habitats, although we have no information on how these impacted water-quality parameters potentially affect northern leatherside chub. Phosphorus is typically in limited supply in aquatic systems and, therefore, excess phosphorus is considered a nutrient pollutant. Excess phosphorus can cause eutrophication, which often results in harmful algal blooms. These algal blooms, in turn, lead to depleted oxygen conditions as they decay (Helfman 2007, p. 176). The State of Idaho adopted guidelines from EPA that monthly averages of total phosphorus should not exceed 0.05 milligram per liter (mg/L) in streams that enter a lake or reservoir and 0.1 mg/L in any stream or other flowing water to avoid eutrophication (IDEQ 2010, p.1).

Trapper Creek, a stream that enters Oakley Reservoir, is currently listed on Idaho's 303(d) list for phosphorous and sediment (Lay 2003, p. 45). Although total phosphorus levels exceeded guidelines in Trapper Creek in almost all sampling events, there was little evidence of eutrophication (nuisance algae growth) (Lay 2003, p. 68). Beaverdam Creek exceeded the 0.1 mg/L total phosphorus limit in 16 out of 41 sampling events (39 percent) in 2001 (Lay 2003, p. 45). Although no eutrophication has been seen, these results suggest that eutrophic conditions could affect aquatic habitats in the future.

Fish need adequate dissolved oxygen in the water to breath. At extremely low oxygen levels, fish suffocation is possible; however, it is very uncommon, as fish have evolved a number of mechanisms to escape this fate (Kramer 1987, p. 81). More common nonlethal effects of reduced dissolved oxygen include reduced growth rates and greater susceptibility to bird predators (fish approach water surface for higher oxygen water and are more easily identified by birds) (Kramer 1987, p. 82). Idaho established a dissolved oxygen minimum concentration of 6 mg/L (Lay 2003, p. 48). This limit considers salmonid spawning requirements (Lay 2003, p. 48) and is likely adequate for northern leatherside chub. Dissolved oxygen levels are not specifically considered to be impaired for Trapper Creek (IDEQ 2010, p. vii) and are likely sufficient to fully support aquatic life, including the northern leatherside chub. It is likely that northern leatherside chub can persist in periodic, short-term, low dissolved oxygen situations because they have been documented to persist in isolated pool environments even after other species have perished (Belk and Johnson 2007, pp. 70–71). It is unclear how they would respond to low dissolved oxygen in the long term, as dissolved oxygen is a key attribute for fish health. However, unless conditions were severe, we would expect any low dissolved oxygen events to be short-term in nature.

Sediment in the water column, also called Total Suspended Solids (TSS), affects fish by reducing feeding abilities (rate and success), degrading habitat (filling interstitial substrate space), and removing oxygen (Newcombe and Jensen 1996, pp. 694–695). Sediment pollution can come from various sources, including, but not limited to, grazing, mining, and dirt roads. Hatchery experiments showed that northern leatherside chub prefer cobble substrates with adequate interstitial space for egg deposition (Billman *et al.* 2008a, p. 278), and field research determined that northern leatherside chub feed on insects in both the water column and the stream substrate (Bell and Belk 2004, p. 414). High sediment loads could interfere with the natural ecology (e.g., feeding and reproduction) of the northern leatherside chub through sedimentation of spawning and feeding habitats. Correspondingly, microhabitat analysis does indicate that sand-silt substrate is negatively associated with leatherside chub presence and leatherside chub are more abundant at locations with gravel substrate (Wilson and Belk 2001, p. 40). However, this analysis did not include any of the large populations now known to inhabit degraded areas, such as Muddy and Upper Twin Creeks, and included only one population now known as northern leatherside chub (Trapper Creek, which is impacted by other ecological factors as well as sediment pollution; the other populations analyzed were southern leatherside chub) (Wilson and Belk 2001, p. 38). Because many of the populations of northern leatherside chub persist in degraded areas and no data exist to clearly link sediment with negative impacts, we conclude that sediment alone is not a threat to northern leatherside chub. However, sediment may act in conjunction with other impacts to threaten populations.

Limits of 25 mg/L TSS will provide a high level of protection for aquatic organisms and 400 mg/L TSS will provide low protection (Lay 2003, p. 47). Idaho uses a monthly average of 50 mg/L TSS and a daily maximum of 80 mg/L TSS as the upper limits for sediment (Lay 2003, p. 47). Both Trapper Creek and Beaverdam Creek exceeded daily maximum and monthly average limits for TSS in 2001. Sediment levels in Trapper Creek are highest following runoff events in the spring (March-May) (IDEQ 2010, p. 6), and appear to negatively affect salmonids in the lower sections of Trapper Creek (Lay 2003, p. 68). One event, from September 2001, documented a monthly average of 1,649 mg/L TSS in Beaverdam Creek, which is about 33 times the established Idaho threshold (Lay 2003, p. 102). Elevated TSS conditions such as this may cause low reproductive or feeding success by filling in substrate used for both egg deposition and macroinvertebrate habitat and reducing visibility for northern leatherside chub.

Thermal pollution (unnatural water temperatures) can affect fish by altering metabolism and stressing biological norms. Thermal limits are unique for each fish species. Idaho has established an upper temperature standard of 22 °C (72 °F) for an instantaneous limit and 19 °C (66 °F) as a daily average for cold water biota (IDEQ 2010, p. 11). We determined that these temperature thresholds are adequately conservative for northern leatherside chub (Lay 2003, pp. 38–39). Northern leatherside chub can tolerate higher stream temperatures than salmonids, are documented to persist in streams as high as 23 °C (73 °F) (Isaak and Hubert 2001, p. 27), and have an upper incipient lethal temperature of 26 to 30 °C (79 to 86 °F) (as temperatures are increased in a tank, this is the temperature at which 50 percent die) (Billman *et al.* 2008b, pp. 463, 468–469). Beaverdam Creek has reached daily averages of 19.32 °C (66.78 °F) and 21.75 °C (71.15 °F), although we do not consider these temperatures to be outside the thermal tolerance range for northern leatherside chub.

Water-quality issues have been documented in Beaverdam and Trapper Creeks within the Goose Creek subbasin, although aquatic communities in each of these creeks still persist. For example, macroinvertebrate communities in Trapper Creek and the upper portions of Beaverdam Creek were considered healthy, and the fish community included species believed to tolerate moderately impaired water quality (Lay 2003, pp. 99–100). However, the macroinvertebrate community in lower Beaverdam Creek was indicative of poor water quality. Although Trapper Creek does not harbor native trout normally associated with cool water systems (Lay 2003, pp. 67, 68), Trapper Creek has been shown to support the designated beneficial uses of cold-water biota and salmonid spawning (IDEQ 2010, p. 9).

In summary, impaired water quality (based on 303(d) lists from the various States) affects the habitat of two populations of northern leatherside chub rangewide (Beaverdam and Trapper Creeks), both in the Idaho portion of the Goose Creek subbasin (Snake River subregion), although we know of no specific information on how impaired water quality may affect the species. Levels of total phosphorus and suspended sediment have been elevated in these streams and resulted in correspondingly low dissolved oxygen levels. Because research cited above demonstrates that elevated sediment, elevated phosphorus, and reduced dissolved oxygen affect fish life-history traits, such as reducing reproductive success (from clogged interstitial space), decreasing feeding success (through impacts to macroinvertebrates), or restricting growth (from low dissolved oxygen levels), it is possible that these conditions have depressed population abundance in these streams.

Only 2 of 14 populations occur in water-quality-impaired streams and these streams are not known to be lethal to aquatic biota. We found no information that water quality may act on this species to the point that the species itself may be at risk, nor is it likely to become so.

Fragmentation and Isolation of Existing Populations

The arrangement, or interconnected nature, of species occurrences is especially important when assessing species vulnerability, because numerous studies link habitat fragmentation to population declines and increased extinction risk (Dunham *et al.* 1997, p. 1126; Fagan *et al.* 2002, p. 3250; Fagan *et al.* 2005, p. 34 and references therein).

Human modifications to stream systems in the western United States, such as reservoir creation, nonnative fish introductions, and irrigation practices, fragment native fish distributions (Dunham *et al.* 1997, p. 1128; Hilderbrand and Kershner 2000, p. 513), including those of the northern leatherside chub (UDWR 2009, pp. 5, 31). In the western United States, physical barriers to dispersal (i.e., dams or culverts) and unsuitable habitat (i.e., lakes, dewatered stretches, or areas with increased predator abundance) are the most common agents of stream fragmentation (Fagan *et al.* 2002, p. 3255).

Fragmentation of stream systems is unique, because unlike terrestrial organisms, fish species are limited to movement through the stream corridor and cannot simply move around an obstruction such as a dam (Neraas and Spruell 2001, p. 1153; Fagan 2002, p. 3243). Because stream fragmentation is often caused by impassable barriers, such as dams or lakes, fish populations become isolated. Whether it is the result of human alterations or natural patchiness in habitat, isolation of local populations increases the risk of extirpation events because immigration and recolonization events, ''rescue effects,'' are precluded (Stacey and Taper 1992, p. 26; Dunham *et al.* 1997, p. 1131; Fagan *et al.* 2002, p. 3250). When new individuals are unable to enter into an area to supplement declining populations or to re-establish a population after a catastrophic extirpation event, it is much more likely the population will disappear permanently. It has been demonstrated that the overall number of occurrences of a species is less important to extinction risk than the fragmentation of occurrences when other variables remain constant (abundance, etc.), with species having a few clustered, interacting populations being less vulnerable to extinction than a species with many, isolated populations (Fagan *et al.* 2002, p. 3254).

It is important to consider the species' mobility and colonization ability when fragmentation is discussed. For many freshwater fish species, most individual fish do not emigrate from their resident home area, but those that do tend to move great distances (Fagan *et al.* 2002, p. 3255). These long-distance dispersers are likely the primary mechanism for the quick recolonization of extirpated stream reaches (Peterson and Bayley 1993, p. 199). We know that the surrogate species southern leatherside chub follows this pattern, with many individuals having high site fidelity, but a small cohort (not dependent on individual size) moving long distances for a small minnow species (0.5 to 2 km (0.3 to 1.25 mi)) over short time spans (within 1 year) (Rasmussen 2010, pp. 42, 48–49). Based on similar physical capabilities and life histories, it is likely that northern leatherside chub can move similar distances. This ability to move provides a mechanism for individuals to leave unsuitable habitat when conditions warrant and to emigrate to new areas for natural demographic reasons.

We conclude that when suitable migratory corridors exist, northern leatherside chub will successfully use them. Supporting this conclusion, the collection of individual northern leatherside chub throughout habitats downstream of known populations may indicate that either yet undocumented populations exist or individuals are migrating into new habitats. Regardless of the distinction, the collection of individual northern leatherside chub found large distances away from known populations, as defined in this finding, supports the conclusion that northern leatherside chub can move large distances when suitable pathways exist. For example, collections of individuals in lower Sulphur Creek and the mainstem Bear River are between 17 and 29 km (10.5 and 18 mi) downstream of the Yellow Creek population and between 11 and 19 km (7 and 12 mi) from the Upper Mill/Deadman Creeks population (approximate distances) (McAbee 2011, p. 6). The occurrence of individuals many kilometers downstream in the large inter-population corridor (whether they be resident or emigrants) supports a conclusion that these two populations could potentially interact because individual presence demonstrates a suitable, occupied pathway exists and is being used. Additionally, individuals collected downstream of the Rock Creek population were between 8 and 13 km (5 and 8 mi) away from the population center (Colyer and Dahle 2010, p. 5), which is a distance similar to that separating the Rock Creek and Upper Twin Creek populations. Similarly, individuals entrained in irrigation canals were 8 km (5 mi) downstream of the Muddy Creek population (Roberts and Rahel 2008, p. 951). Finally, individuals collected in mainstem Goose Creek were between 6 and 18 km (4 and 11 mi) downstream of the Beaverdam Creek population, which is distance similar to that separating the Trout Creek population from Beaverdam (in the opposite direction). Therefore, based on our knowledge of the northern leatherside chub's movement ability and based on the occurrence of individuals many kilometers downstream of extant populations, we conclude that populations separated by moderate-distance (up to about 48 km (30 mi)), barrier-free corridors are able to interact (Table 6).

TABLE 6—SUMMARY OF FRAGMENTATION FOR EXTANT NORTHERN LEATHERSIDE CHUB POPULATIONS

National Hydrography Dataset Locations		Population name	State	Connected to another population	Multiple occurrences	Occurrences within population
Subregion	Subbasin					
Bear River	Upper Bear	Upper Mill/Deadman Creeks.	UT/WY	Yes	Yes	Throughout Mill Creek (UT & WY); Deadman Creek.
		Upper Sulphur/La Chapelle Creeks.	WY	No	Yes	Upper Sulphur Creek; La Chapelle Creek.
		Yellow Creek	UT/WY	Yes	Yes	Throughout Yellow Creek (UT & WY); Thief Creek.
		Upper Twin Creek	WY	Yes	Yes	Clear Creek; North Fork Twin Creek.
		Rock Creek	WY	Yes	No	Rock Creek.
	Central Bear	Dry Fork Smiths Fork.	WY	No	No	Dry Fork Smiths Fork.
		Muddy Creek	WY	Yes	Yes	Muddy Creek; Mill Creek.
Snake River	Snake Headwaters	Pacific Creek	WY	No	No	Pacific Creek.
	Salt River	Jackknife Creek	ID	No	Yes	Jackknife Creek; Squaw Creek; Trail Creek.

TABLE 6—SUMMARY OF FRAGMENTATION FOR EXTANT NORTHERN LEATHERSIDE CHUB POPULATIONS—Continued

NATIONAL HYDROGRAPHY DATASET LOCATIONS		Population name	State	Connected to another population	Multiple occurrences	Occurrences within population
Subregion	Subbasin					
	Goose Creek	Trapper Creek	ID	No	No	Trapper Creek.
		Beaverdam Creek	ID	Yes	No	Beaverdam Creek.
		Trout Creek	NV/ID	Yes	No	Trout Creek.
Green River	Upper Green River/ Slate Creek.	North Fork Slate Creek.	WY	No	Yes	North Fork Slate Creek; Slate Creek.
	Blacks Fork	Upper Hams Fork	WY	No	Yes	Upper Hams Fork; West Fork Hams Fork.

When analyzing the potential threat of fragmentation of northern leatherside chub, we considered two patterns of isolation. First, we assessed the distribution of populations (defined in this finding as an individual or set of 12-digit HUC(s)) across the species' range. For example, we can say that the Jackknife and Pacific Creek populations are isolated from other populations over the range, but the Upper Twin Creek and Rock Creek populations can interact with each other (Table 6). Second, we assessed the occurrences of individuals within the population boundaries, or, more simply stated, how widespread individuals are within the population boundary. For example, we can say that the Pacific and Rock Creek populations have one local occurrence, but that the Jackknife and Upper Twin Creek populations have multiple occurrences within one population boundary (Table 6). In other words, the Jackknife Creek population has a more continuous distribution within the subwatershed, while the Pacific Creek population is isolated to one area.

This two-tiered approach lets us determine the overall extirpation (localized extinction) risk to populations because catastrophic events can range in scale from the entire population area to smaller areas within the population. In the above population isolation example (Jackknife and Pacific Creeks vs. Upper Twin and Rock Creeks), there are no nearby populations to recolonize the Jackknife or Pacific Creek populations if all individuals died from a large-scale disturbance. However, if all individuals in the Rock Creek population died, downstream emigrants from the Upper Twin Creek population could recolonize the area. In the second example, if a catastrophic event affected only part of the Jackknife Creek population (such as the Squaw Creek tributary) and all individuals died, the area could be recolonized by another occurrence (such as the Trail Creek tributary). However, if a catastrophic event affected the single occurrence in Pacific Creek and killed all individuals, the entire population would be extirpated.

For this finding, we classified each population as either isolated or not isolated based on known barriers preventing movement into the population (reservoirs, culverts (Aedo *et al.* 2009, p. 1), or impassable stream distances) (Table 6). If a population could interact with at least one other population, we considered it not isolated. Also, we focused only on permanent barriers, such as large reservoirs or stream distances, instead of temporary barriers, because we assumed permanent barriers will never be bypassed, but temporary barriers could be bypassed at a low frequency with proper conditions. For example, dewatered stretches were not considered a large scale barrier, because in wetter years and wetter seasons they may carry enough water for bypass. Conditions for recolonization or immigration need to occur only sporadically to repopulate areas devoid of fish. Finally, we focused on barriers affecting dispersal only into the population, because we are primarily concerned with recolonization of extirpated areas.

Large reservoirs isolate three populations of northern leatherside chub: Trapper and Jackknife Creeks in the Snake River subregion; and Upper Sulphur/La Chapelle Creeks in the Bear River subregion. Large stream distances isolated three additional populations from all other populations: Pacific Creek in the Snake River subregion; and North Fork Slate Creek and Upper Hams Fork in the Green River subregion. Impassable culverts isolated one more population: Dry Fork Smiths Fork in the Bear River subregion (Trout Unlimited 2010a, p. 7–8). The other seven populations were considered connected to at least one other population. Populations connect primarily in pairs: Muddy Creek and Dry Fork Smiths Fork (Dry Fork Smiths Fork is isolated from Muddy Creek, but not vice versa because culverts are impassable only in the upstream direction); Yellow and Upper Mill/Deadman Creeks; and Rock and Upper Twin Creeks in the Bear River subregion; and Beaverdam and Trout Creeks in the Snake River subregion. These results are summarized in Table 6.

We next determined if each population contained multiple occurrences within the population boundary. We considered a population to have multiple occurrences if multiple tributaries were occupied or northern leatherside chub were in divergent areas of the same stream (separated by at least 10 km (6 mi) of approximate stream distance). Of the 14 northern leatherside chub populations, 3 (Pacific and Trapper Creeks in the Snake River subregion, and Dry Fork Smiths Fork in the Bear River subregion) are isolated and likely contain only one occurrence, making them vulnerable to a large-scale disturbance or stochastic event.

The Trapper Creek population occurs in an upstream tributary to Oakley Reservoir. Oakley Reservoir, and other reservoirs, act as ‘‘environmental filters,’’ preventing movement of small-bodied fish between tributaries and fragmenting distributions (Matthews and Marsh-Matthews 2007, p. 1042). Given the difference in stream and lake habitats, and the presence of large-bodied predators in most reservoirs, we believe it is unlikely that northern leatherside chub could survive migrating through Oakley Reservoir because it supports large populations of piscivorous (fish-eating) rainbow trout (*Oncorhynchus mykiss*) and walleye (*Sander vitreus*) (IDFG 2010a, p. 2; 2010b, p. 3). We are not aware of other northern leatherside chub populations that are located in direct tributaries to a reservoir.

Within the Bear River subregion, culverts surrounding the Dry Fork Smiths Fork population likely prevent any immigration of northern leatherside chub into the population, but do not prevent emigration of individuals out of the population, as the barriers primarily prevent upstream movement. However, the large population size upstream of these culverts indicates that these barriers have not caused a quantifiable impact to population size. In fact, these barriers may be preventing downstream nonnative trout from entering the area, thus protecting the population. Alternatively, these barriers may be causing genetic isolation that could negatively impact the population.

Rangewide, 7 of the 14 northern leatherside chub populations are isolated, which increases risk to large-scale disturbances or stochastic events, such as extreme drought, large wildfire, or invasion of nonnative species (Table 6). Four of the seven have multiple occurrences within the population, offering the potential for rescue effect dynamics. In fact, this situation may have recently played out in the Jackknife Creek population, where a wildfire in 1991 burned a significant portion of the sub-watershed, but did not affect upstream portions of Squaw Creek (Isaak and Hubert 2001, pp. 26–27). It is possible that northern leatherside chub either retreated to suitable habitat within Squaw Creek during and after the fire, or that emigrants from Squaw Creek recolonized other portions of Jackknife Creek.

In summary, isolation and fragmentation of northern leatherside chub populations in stream systems can substantially reduce recolonization potential, and increase the risk of a local extirpation event due to a large-scale disturbance or stochastic event (Fagan *et al.* 2002, p. 3255). When migratory pathways exist, fish species tend to quickly recolonize a stream (Peterson and Bayley 1993, p. 199). However, in desert systems, human modifications have reduced opportunities for recolonization, eliminating the natural counterbalance against extirpation (Fagan *et al.* 2002, p. 3255). Populations able to interact, such as closely distributed populations, are more likely to persist because clustered occurrences increase the probability of recolonization (Fagan *et al.* 2002, p. 3255).

Two fragmented populations of northern leatherside chub, Trapper and Pacific Creeks in the upper Snake River subregion, are isolated from other populations and are vulnerable to stochastic events, including local disturbances, such as disease, pollution, or floods. Conversely, we believe the isolated Dry Fork Smiths Fork population is not as vulnerable to a stochastic event due to its relatively large population and its isolation (due to culverts surrounding the population), which is precluding the migration of the predatory nonnative brown trout into its habitats. Other isolated populations are not impacted by fragmentation (Upper Sulphur/La Chapelle Creek; North Fork Slate Creek; Upper Hams Fork), but their isolation puts them at an increased risk from other large-scale threats and stochastic events. We found no information that fragmentation may act on this species to the point that the species itself may be at risk, nor is it likely to become so.

Summary of Factor A

We found no information that livestock grazing, oil and gas development, mining, water development, water quality, or fragmentation of populations may act on this species to the point that the species itself may be at risk, nor is it likely to become so. While these factors individually have been shown to affect one or a few extant populations of northern leatherside chub, none is considered a significant threat to the species' persistence. For example, stable, reproducing northern leatherside chub populations occur at many locations where degraded habitat conditions exist. While these habitat characteristics may not be optimal for northern leatherside chub populations, their continued persistence and successful reproduction demonstrate that they have some level of tolerance for less than optimal environmental conditions. Because of the sufficient number of populations, the interaction between several population locations, and the large size of many populations, we conclude that local extirpation risk to a small number of populations does not constitute a substantial threat to the species. The best scientific and commercial information available indicates that rangewide the northern leatherside chub is not threatened by the present or future destruction, modification, or curtailment of its habitat or range, nor is it likely to become so.

Factor B. Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

Commercial, recreational, scientific, and educational utilizations are not common northern leatherside chub-related activities, and protections are in place to limit their effect on the species. The use of live baitfish, including northern leatherside chub, is not permitted in the species' range (Harja 2009, p. 4; Miller *et al.* 2009, p. 3; UDWR 2009, p. 32). In addition, we are aware of no evidence that northern leatherside chub are being illegally collected for any purposes.

Across the northern leatherside chub's range, permits are required to collect the species for any reason. Individuals have been collected for genetic analysis from various populations across the species' range (Northern Leatherside Chub Conservation Team 2011, p. 4). These collections were permitted under each State's regulatory authority (see below), and because they are a small portion of the local population, should not negatively impact local population persistence.

Northern leatherside chub are considered a ''prohibited'' species under Utah's Collection, Importation, and Possession of Zoological Animals Rule (R–657–3–1), which makes it unlawful to collect, import, or possess northern leatherside chub without a permit (Harja 2009, p. 4). Use of the species for scientific or educational purposes also is controlled by the UDWR, and the agency reviews requests to make sure that no negative population impacts will occur (Harja 2009, p. 4). Recently, northern leatherside chub were collected for a hatchery population housed in Logan, Utah (Billman *et al.* 2008a, p. 274), and future collections will be required for this population to persist (Northern Leatherside Chub Conservation Team 2010, p. 5). However, the number of northern leatherside chub taken for scientific and educational purposes is low (UDWR 2009, p. 32).

The species is considered ''protected non-game'' under Idaho's Rules Governing Classification and Protection of Wildlife (IDAPA 13.01.06), which makes it unlawful to take or possess northern leatherside chub except with a permit under Rules Governing the Importation, Possession, Release, Sale, or Salvage of Wildlife (IDAPA 13.01.10) (Schriever 2009, p. 1). In Wyoming, a rigorous collection permitting system restricts commercial, scientific, and educational activities (Miller *et al.* 2009, p. 3). Small-scale permits are given to local residents to seine the Bear River drainage for baitfish (dead), but these few permits are not impacting populations of northern leatherside chub (Miller *et al.* 2009, p. 4). Northern leatherside chub is not a protected species in Nevada. However, the Nevada Department of Wildlife (NDOW) regulates collections of northern leatherside chub through a permitting process (Johnson 2011a, pers. comm.).

Summary of Factor B

Northern leatherside chub are not overutilized for commercial, recreational, scientific, or educational purposes. A limited number of northern leatherside chub are collected from wild populations for hatchery augmentation or scientific investigation purposes, but the level of collection is very small. The best scientific and commercial information available indicates that the northern leatherside chub is not threatened by overutilization for commercial, recreational, scientific, or educational purposes, nor is it likely to become so.

Factor C. Disease or Predation

Disease and Parasitism

Disease and parasitism do not affect northern leatherside chub to a significant degree. It is likely that the species encounters natural diseases and parasites. However, we are not aware of any extant, wild population that was substantially impacted by a disease or parasite; no research project or collection effort has documented a disease or parasite problem.

There is no discussion of disease or parasites in the threats section of the Rangewide Conservation Agreement and Strategy for Northern Leatherside Chub (described in detail under Factor D below) (UDWR 2009, p. 32). However, one of the conservation elements in the Conservation Agreement and Strategy is 'Disease Management,' the goal of which is to determine the extent of infections, monitor any known infections, and prevent further infections by implementing biosecurity protocols (UDWR 2009, p. 37). An example of disease management already occurred in Utah, where UDWR raised a broodstock of wild northern leatherside chub and used progeny to repatriate (reintroduce a population) multiple sites (McKay *et al.* 2010, p. 1–3). Fishes brought into the hatchery setting were treated for internal and external parasites (Billman *et al.* 2008a, p. 274), ensuring that all restocked and progeny fish are pathogen-free (Harja 2009, p. 4). The UDWR also minimizes within-hatchery diseases, as demonstrated by their efforts to disinfect eggs for maximum survival (FES 2010, pp. 25, 26).

There are no known disease or parasite problems for the northern leatherside chub. We found no information that disease or parasites may act on this species to the point that the species itself may be at risk, nor is it likely to become so.

Predation

Northern leatherside chub are small minnows, and as such, are prey for larger fish and sometimes birds (Sigler and Sigler 1996, pp. 77–78). Historically, the main piscivorous (fish-eating) predator in northern leatherside chub habitats was cutthroat trout—Bonneville cutthroat trout (*Oncorhynchus clarkii utah*) in the Bear River subregion, and Yellowstone cutthroat trout (*Oncorhynchus clarkii bouvieri*) in the upper Snake River subregion (Greswell 1995, pp. 42–43; May and Albeke 2005, p. 20; Nannini and Belk 2006, p. 458; May *et al.* 2007, p. 15). However, these subspecies likely exerted moderately weak predation pressure on northern leatherside chub over much of their evolutionary history because cutthroat trout only become primarily piscivorous at larger sizes, when they tend to inhabit larger river systems where northern leatherside chub are typically not found (Walser *et al.* 1999, p. 276; Nannini and Belk 2006, pp. 458–459).

Weak predation pressure over evolutionary timescales often results in species losing strong antipredator responses, which in fish species includes escape (strong burst speeds) or concealment (effective camouflage) (Nannini and Belk 2006, pp. 453, 460). In contrast, short timescale adaptations to predation pressure include habitat shifts or populations of lower carrying capacity. Meeting this expectation, southern leatherside chub have slow and non-complex escape responses (Nannini and Belk 2006, p. 460) and respond to intense predation by shifting habitat usage (Walser *et al.* 1999, p. 272). Southern leatherside chub may be more vulnerable to predation risks than other native minnows because they lack effective predator responses, making them a preferred prey (Nannini and Belk 2006, p. 460).

Because they share similar ecological niches, such as habitat associations (Belk and Wesner 2010, p. 12) and native predators, we expect that northern leatherside chub have predator responses similar to southern leatherside chub and also are likely vulnerable to predation. By losing effective antipredator responses, northern leatherside chub were able to divert more energy to other life-history characteristics, such as foraging, reproduction, and growth (Nannini and Belk 2006, p. 460). This adaptation produces benefits under natural, evolutionarily historical conditions where northern leatherside chub primarily coexisted with other small-bodied fish and cutthroat trout species, but places it at a disadvantage when encountering highly predatory species.

One such predatory species is brown trout. Native to Europe and western Asia, brown trout is an introduced predator that was widely stocked throughout the United States for its value as a sportfish (Sigler and Sigler 1996, p. 205; Stoddard *et al.* 2005, pp. 11–12). Brown trout are highly predatory to the detriment of native fish communities, often out-competing and preying on native predators, while also consuming many small, native fish species (Garman and Nielsen 1982, p. 862; Behnke 1992, p. 54; Wang and White 1994, p. 475; Walser *et al.* 1999, p. 272; Budy *et al.* 2005, pp. xii–xiii, 58–73). Brown trout are now commonly distributed throughout adequate habitats in the Bear and upper Snake River subregions and have affected native fish in these areas. They have displaced native cutthroat species (Budy *et al.* 2005, p. xii), limiting cutthroat trout populations to mostly headwater streams where temperatures are generally too cold for brown trout survival. Therefore, it is likely that this introduced predator reduced the historical range of northern leatherside chub.

The closely related southern leatherside chub has altered habitat selection because of predation pressure by brown trout (Walser *et al.* 1999, p. 272). This outcome is not surprising, given that: (1) Piscivory is a dominant factor shaping fish community structure in stream ecosystems (Jackson *et al.* 2001, p. 157); (2) other prey species retreat to safer periphery habitat when faced with predation risks (Fraser *et al.* 1995, p. 1466); and (3) introduced populations of brown trout have affected native species worldwide (McDowall 2003, pp. 230–231). For example, in Diamond Fork Creek, Utah, southern leatherside chub inhabited less suitable, lateral habitats (cutoff pools and backwaters) when the main channel contained brown trout, despite the presence of suitable main channel microhabitats (Walser *et al.* 1999, p. 272). Because unoccupied main channel habitats were identical to those occupied in streams without brown trout, it is likely that southern leatherside chub select poorer quality habitat to avoid brown trout predation (Walser *et al.* 1999, p. 275). This hypothesis was confirmed on a broad geographic scale. In areas where brown trout populations overlapped with juvenile mountain sucker (*Catostomus platyrhynchus*) and southern leatherside chub, the latter two species used backwaters and cut-off pools almost exclusively, whereas in the absence of brown trout, they commonly used main channel pools (Olsen and Belk 2005, pp. 501, 503). This suggests that predation is an important factor affecting habitat use by small native fish, limiting them to areas of less suitable habitat.

Although considered poorer habitats than the main channel, lateral areas likely offer native fish their only chance of persistence, because brown trout will prey on individuals in main channel habitats. Therefore, it is important to preserve lateral habitats where northern leatherside chub and brown trout overlap, because even with brown trout present, small native fish can survive with adequate habitat complexity (Olsen and Belk 2005, p. 504). Side channel habitats are only available in natural systems with adequate flow, not degraded or simplified systems, such as de-watered or channelized streams (Olsen and Belk 2005, p. 504). In the event that refuge areas are not available, it is not likely that northern leatherside chub populations can persist under such heavy predation pressure.

Based on an analysis of brown trout and southern leatherside chub, we expect that when refuge habitat is not available, brown trout predation exerts direct mortality on northern leatherside chub. Stream experiments revealed that southern leatherside chub are 16 times more likely to survive if brown trout are absent than if present (Nannini and Belk 2006, p. 458), which explains why lateral habitats are a safer option. For example, in Diamond Fork Creek, southern leatherside chub were absent in upstream areas without lateral habitats in 1999 (Walser *et al.* 1999, p. 276). Later, when flows were permanently reduced throughout Diamond Fork Creek by a water conveyance pipeline, lateral habitats disappeared completely and southern leatherside chub were soon extirpated from the entire system, presumably from brown trout predation (Hepworth and Wiley 2007, pp. 3–4).

Although brown trout and northern leatherside chub can co-occur, the presence of brown trout potentially impacts northern leatherside population densities in 3 of 14 populations (Jackknife Creek, Dry Fork Smiths Fork, and Muddy Creek). Brown trout were negatively correlated with the probability of encountering southern leatherside chub over many tributaries in the Sevier River drainage (Wilson and Belk 2001, p. 39). Areas with high densities of southern leatherside chub were always free of brown trout, and areas where the two species overlapped had consistent low densities of southern leatherside chub (Wilson and Belk 2001, p. 41). Low population densities are likely a result of cumulative losses of individuals to predation, preventing populations from reaching carrying capacity.

Even when brown trout do not inhabit the same location as northern leatherside chub, brown trout can exert indirect pressure on the species by acting as a migration barrier. Effective aquatic predators can act as a dispersal barrier by killing prey (Fraser *et al.* 1995, pp. 1461, 1468). Therefore, the predation pressure on main channel habitats (Walser *et al.* 1999, p. 272) may prevent northern leatherside chub from moving between populations, exacerbating an already fragmented species distribution. However, like resident fish, emigrants are more likely to survive migrations when complex habitat (through adequate water supply) is available (Gilliam and Fraser 2001, pp. 267, 270).

More broadly, predators can fragment an otherwise consolidated distribution of prey species, forcing the prey to abandon otherwise habitable areas for constricted peripheral locations (Fraser *et al.* 1995, p. 1461). In fact, it is possible that through past population extirpations combined with current migration impediments, brown trout are the cause of the current fragmentation of leatherside populations (Wilson and Belk 2001, p. 41).

An analysis of the range contraction of northern leatherside chub compared to brown trout stocking offers some insight into the relationship between the two species (current fish stocking policies are analyzed under Factor D). Between 1975 and 2005, the States of Utah and Wyoming stocked at least 2.28 million brown trout in the Bear River subregion (IDFG 2010c, entire; UDWR 2010, pp. 1–747; WGFD 2010, pp. 1–10). Recent surveys indicate that no extant northern leatherside chub populations are in close proximity to the stocking locations (Service 2011, pp. 33–34). While this could be simply an artifact of suitable habitat or preferential stocking locations, we conclude that the instances of historical extirpation combined with the ecological influences described above suggest a more causative effect.

Further support of this causative effect is documented in Utah. Between 1981 and 2005, approximately 400,000 brown trout were stocked in the Little Bear/Logan subbasin (UDWR 2010, pp. 1–747), where northern leatherside chub historically occurred but are no longer found (UDWR 2009, p. 42). Surveys of historical northern leatherside chub locations in the nearby Lower Bear subbasin also yielded no northern leatherside chub, but did document large numbers of brown trout (UDWR 2009, p. 42). Although there are no voucher specimens of northern leatherside chub for these historical locations, UDWR considers collections in the Little Bear River (four preserved skeletons) as reliable because of the reputation of the collector (W.F. Sigler) (McKay 2011, pers. comm.). It is not unreasonable to conclude that high densities of brown trout removed northern leatherside chub from these locations.

Stocking of brown trout also occurred in subbasins with extant northern leatherside chub. Near the Utah-Wyoming border, Utah and Wyoming stocked around 250,000 brown trout in the mainstem Bear River from 1980 to 1997, and Wyoming stocked around 500,000 in Woodruff Reservoir from 1985 to 1997 (UDWR 2010, pp. 1–45; WGFD 2010, pp. 7–10). These locations centralize an area of unoccupied habitat between the two sets of populations in the Upper Bear subbasin. In the Salt River subbasin, northern leatherside chub no longer occur in any tributaries stocked with brown trout. Lastly, Wyoming stocked around 250,000 brown trout in Sulphur Creek Reservoir, directly downstream of the Sulphur/LaChapelle Creeks population before 2000 (WGFD 2010, pp. 3–6), possibly isolating that population of northern leatherside chub completely. Therefore, it is possible that past stocking events and subsequent migration of brown trout shaped the current distribution of northern leatherside chub and could prevent many populations from interacting in the future.

Within the Snake River drainage, populations of northern leatherside chub persist in at least two streams where brown trout were historically stocked. In the Goose Creek subbasin, Nevada has not stocked brown trout since 1950 (Johnson 2010, pers. comm.), nor has Utah recently stocked any nonnative trout (Schaugaard and Thompson 2006, pp. 5–6). Idaho stocked about 5,500 brown trout in Trapper Creek in 1988 (IDFG 2010c, p. 10), but they did not persist, as rainbow trout are the only salmonid recently collected in the stream (Keeley 2010, pp. 3–4). Leatherside chub and brown trout also were found together at two sites in Jackknife Creek, but brown trout made up less than 6 percent of salmonid abundance at both sites (Univeristy of Wyoming 2010, pp. 1–4). In contrast, in the Twin Creek drainage, where a solely native fish community resides, two northern leatherside chub populations currently persist, with individuals in many tributaries (Colyer and Dahle 2010, p. 5).

The presence of brown trout can cumulatively intensify abiotic factors, such as reduced water level from drought or irrigation, or increased stream temperature from climate change (see discussion under Factor E). As was demonstrated in Diamond Fork Creek, reduced water levels force native, small-bodied fish from refuge habitat to main channel habitat, where brown trout can easily prey on them. In fact, brown trout will prey on southern leatherside chub preferentially over redside shiner (Nannini and Belk 2006, p. 458). The relationship between water level and brown trout presence also potentially impacts migration patterns. Water levels do not affect prey fish movement in the absence of predators; however, water levels are an issue when predators are present (Gilliam and Fraser 2001, p. 270). In other words, when stream levels are low from drought or human use, northern leatherside chub are predicted to move freely if brown trout are absent, but will likely not move if brown trout are present. Water level is rendered influential only when a predator is present (Gilliam and Fraser 2001, p. 270).

Northern leatherside chub populations can endure if brown trout are absent or at very low densities. However, based on the ecological mechanisms described above and the lack of strong overlapping distribution, we conclude that future introduction of brown trout into streams with extant northern leatherside chubs, although not currently anticipated, would likely impact those populations.

Other salmonid species, both native and nonnative, could impact northern leatherside chub populations through predation as well. Although not normally as piscivorous as brown trout, introduced rainbow trout impact native fish communities worldwide (Lintermans 2000 in Blinn *et al.* 1993, p. 139; McDowall 2003, p. 231; Vigliano *et al.* 2009, p. 1406). In fact, rainbow trout likely influence habitat use, behavior, and distribution of another *Lepidomeda* species, the Little Colorado spinedace (*L. vittata*) (Blinn *et al.* 1993, pp. 141–142). The Little Colorado spinedace is similar to northern leatherside chub, in that it evolved without strong predation pressure but is now forced into suboptimal habitats by an introduced predator (Blinn *et al.* 1993, p. 142). We conclude that the introduction of rainbow trout also poses a threat, albeit less than brown trout, because rainbow trout exert similar nonnative predation pressure on northern leatherside chub.

Brook trout (*Salvelinus fontinalis*) are another nonnative trout species occurring in the northern leatherside chub's range. While brook trout are commonly referred to as carnivorous, voracious feeders, they primarily feed on insects throughout their life but will eat fish when possible (Sigler and Sigler 1996, p. 211). Amazingly, they are known to eat amphibians, reptiles, and mammals on rare occasions, demonstrating their variable diet (Sigler and Sigler 1996, p. 211). However, it is important to note that even large brook trout are not especially piscivorous (Sigler and Sigler 1996, p. 211), making them less of a predatory threat than either brown or rainbow trout.

The most likely impact of brook trout on northern leatherside chub is competition for available resources. Brook trout populations are known to become locally overabundant to the point that the size class of the population is stunted and resources are scarce (Sigler and Sigler 1996, pp. 212–213). However, brook trout inhabit coldwater habitats, such as cool, clear headwater streams and spring-fed streams and lakes (Sigler and Sigler 1996, p. 212). They seek water temperatures of 10 to 14.4 °C (50 to 58 °F), high-gradient streams (3 to 6 percent), and gravel substrate (Sigler and Sigler 1996, pp. 211–212; Nadolski 2008, p. 63). In contrast, northern leatherside chub occupy streams with higher temperatures (15.6 to 20 °C or 60 to 68 °F) (Sigler and Sigler 1996, p. 79), prefer low stream gradients (0.1 to 4 percent (Wilson and Belk 2001, p. 39)), and can tolerate sediment-laden habitats (UDWR 2009, p. 27).

Based on available information, we conclude that brook trout pose a very limited threat to northern leatherside chub even though brook trout occur both upstream and concurrently with 6 of 14 northern leatherside chub populations. Habitats that are occupied by northern leatherside chub are likely suboptimal for brook trout. While populations of the two species overlap, densities of brook trout are generally low in these locations, while densities of northern leatherside chub are generally stable and relatively high. We also conclude that upstream populations of brook trout are not a threat because many are characterized by abundant, small individuals that are not piscivorous and inhabit areas unlikely to support northern leatherside chub if they were removed (Nadolski 2008, pp. 78–79; WGFD 2009, p. 5). For example, at Deadman Creek, brook trout have seemingly overpopulated the portions upstream of a dense northern leatherside population (Nadolski 2008, p. 78). However, the brook trout population is comprised of small, sedentary, non-piscivorous fish (Nadolski 2008, p. 38; 2011 pers. comm.). We note that this is the only population where brook trout stomach contents have been collected, and it would improve our understanding of the species if more investigations studied the interactions between brook trout and northern leatherside chub. As discussed in more detail under Factor E (climate change), predation impacts from brook trout are not expected to increase if climate change predictions are accurate. Warming waters (either from increased air temperatures or drought conditions) may benefit northern leatherside chub and harm brook trout, as northern leatherside chub are more tolerant and ecologically adapted to warmer water temperatures.

The presence of native cutthroat trout species poses a very limited risk to northern leatherside chub persistence because cutthroat trout are a natural predator that does not exert excessive predation pressure. In fact, conservation actions that remove nonnative trout and introduce native cutthroat will likely produce beneficial effects to northern leatherside chub through reduced predation.

To fully assess the threat of nonnative trout, we assessed the probability that nonnative trout could currently alter populations or invade existing northern leatherside chub populations in the future. Fish stocking policies have recently changed, resulting in a large reduction of brown trout stocking in the area. An analysis of recent collection data shows that nonnative trout populations are nearby 8 of the 14 extant northern leatherside chub populations, although the number is reduced to only 5 when brook trout (which are less piscivorous) are excluded (Table 7).

TABLE 7—PRESENCE OF NONNATIVE SALMONIDS (BROOK, BROWN, AND RAINBOW TROUT) AND NATIVE CUTTHROAT TROUT AT EXTANT NORTHERN LEATHERSIDE CHUB POPULATIONS

National Hydrography Dataset Boundaries		Population	Presence of Salmonids	
Subregion	Subbasin		Nonnative (brook, brown, or rainbow)	Native cutthroat
Bear River	Upper Bear	Upper Mill/Deadman Creeks	Brook trout upstream	Yes.

TABLE 7—PRESENCE OF NONNATIVE SALMONIDS (BROOK, BROWN, AND RAINBOW TROUT) AND NATIVE CUTTHROAT TROUT AT EXTANT NORTHERN LEATHERSIDE CHUB POPULATIONS—Continued

National Hydrography Dataset Boundaries		Population	Presence of Salmonids	
Subregion	Subbasin		Nonnative (brook, brown, or rainbow)	Native cutthroat
		Upper Sulphur/La Chapelle Creeks.	No	Yes.
		Yellow Creek	No	Yes.
		Upper Twin Creek	No	Downstream.
		Rock Creek	No	Yes.
	Central Bear	Dry Fork Smiths Fork	Brown & brook trout downstream	Downstream.
		Muddy Creek	Brown & brook trout downstream	Downstream.
Snake River	Snake Headwaters	Pacific Creek	Brook trout present	Yes.
	Salt River	Jackknife Creek	Brown trout downstream	Yes.
	Goose Creek	Trapper Creek	Rainbow trout present	No.
		Beaverdam Creek	No	No.
		Trout Creek	No	Yes.
Green River	Upper Green River/Slate Creek.	North Fork Slate Creek	Brook trout upstream	No.
	Blacks Fork	Upper Hams Fork	Rainbow present/Brook trout upstream.	No.

In the Bear River subregion, the only populations accessible by nonnative trout are the Dry Fork Smiths Fork, Muddy Creek, and Upper Mill/Deadman Creeks populations. Although the Muddy Creek and Dry Fork Smiths Fork populations do not currently have nonnative trout in occupied northern leatherside chub habitat, downstream tributaries in the Smiths Fork drainage (not occupied by northern leatherside chub) contain brown and brook trout (Roberts and Rahel 2008, p. 951; Trout Unlimited 2010b, pp. 78–91, Table 6). Muddy Creek is accessible to these downstream populations, because there is no barrier separating the areas (Colyer and Dahle 2007, p. 8), but Dry Fork Smiths Fork is isolated by impassable culverts (Trout Unlimited 2010a, pp. 7–8, 10–12). However, the aquatic habitat in Muddy Creek is currently unsuitable for brown trout, likely preventing their colonization of the area. Brook trout are currently found upstream of occupied northern leatherside habitat in Deadman Creek, but not in the rest of the system (Nadolski and Thompson 2004, p. 3; Nadolski 2008, p. 78; Belk and Wesner 2011, pp. 1–4).

Although Sulphur Creek Reservoir, downstream of the Upper Sulphur/La Chapelle Creeks population, contains brown and rainbow trout, we conclude they cannot access northern leatherside chub habitat. Prior to 2000, the WGFD stocked thousands of brown trout in Sulphur Creek Reservoir (WGFD 2010, pp. 3–6), creating a possible source for colonization into the Upper Sulphur/La Chapelle Creeks population. However, no brown trout were collected in upstream reaches occupied by northern leatherside (Belk and Wesner 2011, pp. 1–4). Brown trout have not moved upstream likely because there are abundant food resources in the reservoir and habitat directly upstream of the reservoir is degraded by irrigation return flow (Amadio 2011, pers. comm.).

In the upper Snake River subregion, nonnative trout co-occur with leatherside chub in two of the five populations and are downstream of another population. Brown trout are found in lower reaches of Jackknife Creek and were previously shown to co-occur with northern leatherside chub (Isaak and Hubert 2001, pp. 6, 27), although more recently brown trout were not found at occupied northern leatherside chub sites (Keeley 2010, pp. 45–60). Although brook trout inhabit the same reach of Pacific Creek occupied by northern leatherside chub, they generally use different habitats (Grand Teton National Park 2009, p. 1). Introduced rainbow trout are documented in Trapper Creek (Keeley 2010, pp. 4–5), although information is lacking on what if any impact they have on the northern leatherside chub population.

In the Green River subbasin, both northern leatherside chub populations occur downstream of brook trout (WGFD 2009, pp. 1–5). In addition, low densities of rainbow trout occur in the Upper Hams Fork, but they are likely not reproducing (WGFD 2009, pp. 1–3).

Summary of Predation

Nonnative predators, especially brown trout, impact northern leatherside chub populations. In the presence of brown trout, leatherside chub occupy lateral habitats that could provide refuge against predation (Walser *et al.* 1999, p. 272), likely reducing reproductive and forage success. Brown trout hold leatherside chub populations at low density (Wilson and Belk 2001, p. 41), likely because leatherside chub are preferred prey (Nannini and Belk 2006, p. 458).

While the stocking of brown trout has been greatly reduced in recent years in several streams within the range of northern leatherside chub, established brown trout populations are likely sustainable in many locations, as shown in the Salt River subbasin (Isaak and Hubert 2001, p. 6). Currently, the distribution of brown and rainbow trout overlaps with northern leatherside chub populations only in a few locations (Trapper Creek, Upper Hams Fork, and the lowest portion of Jackknife Creek). Any changes in current stream conditions (i.e., changing water quality and temperatures) could facilitate upstream distributional shifts for these nonnatives, putting northern leatherside chub at increased risk of predation. For example, if the projected changes in climate warms waters across the western United States (EPA 2008, p. 8), brown trout could possibly move upstream into currently occupied northern leatherside chub habitats; however, we have no specific information to indicate that this is likely to happen.

In summary, we found no information that predation may act on this species to the point that the species itself may be at risk, nor is it likely to become so. Most populations (9 of 14) do not share habitats with nonnative trout of concern, and 3 of 5 potentially impacted populations occur where habitats are likely not suitable for salmonids (i.e., Muddy Creek), contain migration barriers in the form of impassable culverts (i.e., Dry Fork Smiths Fork), or have only low densities of the nonnative rainbow trout (i.e., Upper Hams Fork). Therefore only two northern leatherside chub populations (in the Snake River subregion) may be vulnerable to the effects of nonnative trout. However, we have no information to indicate how the species and its habitats have been impacted. Brown trout occur in the lower reaches of Jackknife Creek, primarily downstream of northern leatherside chub populations in warmer waters (although they have been found to co-occur in past samples). Rainbow trout continue to co-occur with northern leatherside chub in Trapper Creek where the IDFG continues to stock nonnative rainbow trout into Oakley Reservoir. Because nonnative trout impact a small proportion of populations, predation does not act on this species to the point that the species itself may be at risk, nor is it likely to become so.

Summary of Factor C

At this time we know of no information that indicates that the presence of parasites or disease significantly affects northern leatherside chub, or is likely to do so. There is strong evidence that northern leatherside chub can be impacted by predation from nonnative trout, especially brown trout. Nonnative trout currently occur near or downstream to 5 of 14 northern leatherside chub populations. While these populations are more vulnerable to predation and other effects from nonnative trout, we have no information that indicates nonnative trout are currently impacting these populations or the species as a whole. We found no information that disease or predation may act on this species to the point that the species itself may be at risk, nor is it likely to become so.

Factor D. The Inadequacy of Existing Regulatory Mechanisms

The Act requires us to examine the inadequacy of existing regulatory mechanisms with respect to extant threats that place northern leatherside chub in danger of becoming either endangered or threatened. Regulatory mechanisms affecting the species fall into three general categories: (1) Land management; (2) State mechanisms; and (3) Federal mechanisms.

Land Management

Land ownership in the entire upland watershed affects aquatic habitats because land activities distribute effects downslope into the stream corridor. Subwatersheds harboring populations of northern leatherside chub are distributed across BLM, private, State, USFS, and National Park Service (NPS) lands and incur varying regulatory mechanisms depending on land ownership (USFWS 2011, pp. 11–17). The following section provides a brief description of how land ownership affects regulatory mechanisms where extant northern leatherside chub populations occur. We first analyze the land ownership of the entire upland area to analyze general effects, and then analyze local riparian corridor ownership to investigate more local effects.

Currently occupied northern leatherside chub streams are contained in 14 populations based on subwatersheds (HUC12) covering approximately 242,864 hectares (938 square mi). Land ownership in occupied subwatersheds is comprised of privately owned land (31.5 percent in the States of Idaho, Nevada, Utah, and Wyoming), as well as lands managed by BLM (30 percent), NPS (3.5 percent), USFS (30.5 percent), and the States of Wyoming (4.3 percent) and Idaho (0.04 percent) (Service 2011, pp. 11–17). Aside from the subwatersheds in the Upper Bear River subbasin (Upper Mill/Deadman Creeks, Upper Sulphur/La Chapelle Creeks, and Yellow Creek), which are almost entirely privately owned, most northern leatherside chub subwatersheds are affected by upstream lands that are managed by the BLM and the USFS, or the NPS for Pacific Creek (Table 8). However, more than three-quarters of northern leatherside chub subwatersheds have some, or their entire, occupied habitat on private lands, which typically encompasses the wetted channel and the riparian buffer surrounding the stream (Table 9).

TABLE 8—LAND OWNERSHIP BY PERCENT OF SUBWATERSHEDS (12-DIGIT HUC) WITH NORTHERN LEATHERSIDE CHUB POPULATIONS

Population name	Upland watershed land ownership by entity (% land owned)				
	BLM	Private	State	USFS	NPS
Bear River Subregion					
Upper Mill/Deadman Creeks	0	68	1	31	0
Upper Sulphur/La Chapelle Creeks	6	88	6	0	0
Yellow Creek	1	95	4	0	0
Upper Twin Creek	77	14	6	0	3
Rock Creek	61	19	10	0	10
Dry Fork Smiths Fork	40	26	10	24	0
Muddy Creek	63	19	18	0	0
Total	45	41	8	3	3
Snake River Subregion					
Pacific Creek	0	4	0	48	48
Jackknife Creek	1	5	0	94	0
Trapper Creek	12	5	1	82	0
Beaverdam Creek	19	8	1	72	0
Trout Creek	41	8	0	51	0
Total	9	5	<1	71	15

TABLE 8—LAND OWNERSHIP BY PERCENT OF SUBWATERSHEDS (12-DIGIT HUC) WITH NORTHERN LEATHERSIDE CHUB POPULATIONS—Continued

Population name	Upland watershed land ownership by entity (% land owned)				
	BLM	Private	State	USFS	NPS
Green River Subregion					
North Fork Slate Creek	88	9	3	0	0
Upper Hams Fork	12	13	2	73	0
Total	30	13	2	55	0

TABLE 9—ESTIMATED LAND OWNERSHIP IN MILES FOR OCCUPIED HABITAT OF NORTHERN LEATHERSIDE CHUB POPULATIONS

Population name	Land ownership of occupied habitat					Approximate river miles of occupied habitat
	BLM (percent)	Private (percent)	State (percent)	USFS (percent)	NPS (percent)	
Bear River Drainage						
Upper Mill/Deadman Creeks	0	100	0	0	0	10
Upper Sulphur/La Chapelle Creeks	0	100	0	0	0	15
Yellow Creek	2	96	2	0	0	27
Upper Twin Creek	40	40	20	0	0	9
Rock Creek	30	70	0	0	0	3
Dry Fork Smiths Fork	65	35	0	0	0	3
Muddy Creek	5	0	95	0	0	5
Snake River Drainage						
Pacific Creek	0	0	0	0	100	2
Jackknife Creek	0	0	0	100	0	8
Trapper Creek	15	60	0	25	0	8
Beaverdam Creek	20	50	0	30	0	3
Trout Creek	10	90	0	0	0	5
Green River Drainage						
North Fork Slate Creek	80	20	0	0	0	9
Upper Hams Fork	10	15	15	60	0	10
Total Estimated River Miles	....	....	....	....	....	117

Quantifying riparian habitat ownership for areas surrounding occupied northern leatherside chub stream reaches required an internal investigation. No published information is available regarding the number of river-kilometers occupied by northern leatherside chub populations; therefore, we calculated a basic estimate by using presence and absence data supplied by various researchers and agencies. Our estimate indicates that occupied river-kilometers for northern leatherside chub are approximately 188 km (117 mi). This total includes approximately 115 km (72 mi) on private land in Idaho, Nevada, Utah, and Wyoming; 29 km (18 mi) on lands managed by the BLM; 14 km (9 mi) on lands managed by the States of Wyoming and Idaho; and 3 km (2 mi) and 27 km (17 mi) on lands managed by the NPS and USFS, respectively (Table 9). Thus, a total of 61 percent of the estimated occupied northern leatherside chub habitat in the 4–State area occurs on privately owned land (Service 2011, pp. 11–17).

Subwatersheds with significant portions of federally owned land allow for greater regulatory control over land management practices (oil and gas development, grazing, water development, mining, etc.) that have the potential to negatively affect northern leatherside chub populations and their habitat. Federal agencies conduct land management activities under various legislations (see Federal Mechanisms below) that do not apply to private lands. On private lands, the Clean Water Act (CWA; 33 U.S.C. 1251 *et seq.*) and State mechanisms (see below) are the primary regulatory mechanisms that regulate land use activities.

State Mechanisms

Collection or Possession

Northern leatherside chub are considered ''prohibited'' species under the Utah Collection Importation and Possession of Zoological Animals Rule (R–657–3–1), making them unlawful to collect or possess (UAC 2011, pp. 18–19). These species receive protection from unauthorized collection and take. In Wyoming, the use of live baitfish is prohibited throughout the range of northern leatherside chub and very few live baitfish collection licenses are sold in the Bear River drainage. Persons that have these permits collect baitfish on a small scale for individual use (Miller *et al.* 2009, pp. 3–4) (see discussion under Factor B). The State of Idaho has classified northern leatherside chub as a ''Protected Nongame'' species, and State regulations specify that no person shall take or possess such species at any time or in any manner except as provided for in authorized circumstances (Schriever 2009, p. 1). Northern leatherside chub are not listed as a protected species in the State of Nevada; however, the use of live baitfish is prohibited in the State within the species' range, and the NDOW monitors collection of rare species by researchers (UDWR 2009, pp. 32–33). These policies are adequately protecting northern leatherside chub from overutilization (see Factor B discussion) and are not expected to change in the future.

Conservation and Protection

The States of Idaho, Wyoming, Nevada, and Utah provide protection and conservation direction for northern leatherside chub under their State comprehensive wildlife conservation strategies, which are required by the Service for a State wildlife agency to receive State wildlife grants. In addition, all States within the range of the species are signatory to the ''Rangewide Conservation Agreement and Strategy for Northern Leatherside''. The goals of this document are to ensure the long-term persistence of the northern leatherside chub within its historical range and to support the development of multi-State conservation efforts through coordinated conservation actions and regulatory consistency. The objectives of the document are to identify and reduce threats to northern leatherside chub and its habitat, determine the existing range of the species, maintain and monitor existing self-sustaining populations and their habitat, restore populations at selected localities within the historical range, augment selected populations if necessary, maintain genetic diversity, and pursue additional research questions (UDWR 2009, p. 1). Other signatories to the document include the Service, BLM, NPS, Bureau of Reclamation, USFS, Trout Unlimited, and The Nature Conservancy (UDWR 2009, pp. 2–3). While we do not rely on these strategies for our finding, they are extremely valuable because they help prioritize conservation actions within each State and form partnerships across the species' range (UDWR 2009, entire). These policies are not expected to change in the future.

Fish Stocking

The UDWR follows their Policy for Fish Stocking and Transfer Procedures, and no longer stocks nonnative fish into northern leatherside chub habitat (UDWR 2009, p. 32). This Statewide policy specifies protocols for the introduction of nonnative species into Utah waters and states that all stocking actions must be consistent with ongoing recovery and conservation actions for State of Utah sensitive species, including northern leatherside chub. The Nevada Board of Wildlife Commissioners has enacted Commission Policy Number 33, which states that waters or reaches of waters managed as ''wild'' or ''native'' will not be stocked with hatchery trout (State of Nevada Board of Wildlife Commissioners 1999, p. 5). This includes northern leatherside chub waters; therefore, no stocking is done within the range of the species in Nevada (Johnson 2011b, pers. comm.). In Wyoming, northern leatherside chub waters were historically stocked. There is now better awareness of northern leatherside chub-occupied habitat, and the State generally does not stock in these waters (Miller 2011, pers. comm.). The State of Idaho operates similar to Wyoming, and there is an informal policy that discourages stocking of salmonids in northern leatherside chub habitat (Grunder 2011, pers. comm.). Although we did not rely on these policies for our finding, the implementation of such policies affords adequate protection to northern leatherside chub. These policies are not expected to change in the future.

Water Rights

To a considerable extent, water rights are managed under State law in the four States with northern leatherside chub-occupied habitat. The doctrine of prior appropriation or ''first in time—first in right'' is the basis for administering surface water rights, and each State does so via a State agency, a State Engineer, or some combination of the two (BLM 2001, entire). As discussed under Factor A (Water Development), much of the northern leatherside chub-occupied habitat was historically impacted by surface water development and diversion. Currently, occupied subwatersheds in Utah and Idaho are closed to new water appropriations for any significant consumptive use such as large-scale irrigation (Dean 2011, pers. comm.; Jordan 2011, pers. comm.). However, subwatersheds occupied by northern leatherside chub in Nevada and Wyoming are still open to new water appropriations (Randall 2011, pers. comm.; Jacobs and Brosz 2000, p. 7). As described under Factor A (Water Development), this level of water development is not a significant threat to extant populations of northern leatherside chub because populations are able to reoccupy temporarily dewatered areas when flows return, and because low water conditions do not threaten the species because they evolved to persist in drought conditions. Future water development in Utah and Idaho is limited, and limited increases in surface water usage are predicted for Nevada (Randall 2011, pers. comm.) and Wyoming (Schroeder and Hinckley 2007, pp. 6–2 to 6–4) within the range of the species, indicating that water development in these States is not a significant threat, nor is it likely to become so. Available information indicates that the State regulatory mechanisms in existence adequately protect the northern leatherside chub from the threat of reduction of habitat due to water development projects.

Federal Mechanisms

The major Federal mechanisms for protection of northern leatherside chub and its habitat are through the CWA section 404 permitting process, the CWA section 303(d) impaired water body list, and the National Environmental Policy Act (42 U.S.C. 4231 *et seq.*) (NEPA). Various Executive Orders (11990 for wetlands, 11988 for floodplains, and 13112 for invasive species) provide guidance and incentives for Federal land management agencies to manage for habitat characteristics essential for conservation. As explained below, Federal land management agencies (BLM, USFS, and NPS) have legislation that specifies how their lands are managed for sensitive species.

As stated above in the Land Management section, approximately two-thirds of the lands in subwatersheds with northern leatherside chub are managed by Federal land agencies, and approximately one-third of all occupied stream miles are on these lands. The northern leatherside chub is designated as a sensitive species by the BLM in Utah, Wyoming, Nevada, and Idaho. The policy in BLM Manual 6840-Special Status Species Management states: ''Consistent with the principles of multiple use and in compliance with existing laws, the BLM shall designate sensitive species and implement species management plans to conserve these species and their habitats and shall ensure that discretionary actions authorized, funded, or carried out by the BLM would not result in significant decreases in the overall range-wide species population and their habitats'' (BLM 2008, p. 10). BLM land management practices are intended to avoid negative effects whenever possible, while also providing for multiple-use mandates; therefore, maintaining or enhancing northern leatherside chub habitat is being considered in conjunction with other agency priorities. Available information indicates that BLM management policies are currently adequately reducing impacts to northern leatherside chub on BLM land.

The USFS Sensitive Species Policy in Forest Manual 2670 outlines procedures for conserving sensitive species. The policy applies to projects executed under the 1982 National Forest Management Act (NFMA) implementing regulations. The range of the northern leatherside chub is within USFS Region 4 (Intermountain Region), where it is designated a sensitive species by the USFS (USFS 2010, p. 5), and where the National Forests have land and resource management plans developed under NFMA. The USFS manuals and handbooks codify the agency's policy, practices, and procedures and are sources of administrative direction for USFS employees.

The USFS Region 4 applies practices outlined in their Soil and Water Conservation Practices Handbook to northern leatherside chub habitat (USFS 1988, pp. 1–71). This handbook states that the USFS will apply watershed conservation practices to sustain healthy soil, riparian, and aquatic systems. The handbook provides management measures with specific criteria for implementation. For example, Management Measure No. 11.01 states: ''The Northern and Intermountain Regions will manage watersheds to avoid irreversible effects on the soil resource and to produce water of quality and quantity sufficient to maintain beneficial uses in compliance with State Water Quality Standards.'' Irreversible effects include reduced natural woody debris, excess sediment production that could reduce fish habitat, water temperature and nutrient increases that could affect beneficial uses, and compacted or disturbed soils that could cause site productivity loss and increased soil erosion. The USFS land management practices are intended to avoid these effects whenever possible, while also providing for multiple-use mandates; therefore, maintaining or enhancing northern leatherside chub habitat is being considered in conjunction with other agency priorities. Available information indicates that USFS and BLM management policies are adequately reducing impacts to northern leatherside chub on USFS land.

The National Park Service Organic Act (16 U.S.C. 1 *et seq.*) specifies that the NPS will ''promote and regulate the use of the Federal areas known as national parks, monuments, and reservations * * * which purpose is to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations.'' Consequently, livestock grazing, timber harvest, mining, and water development do not occur in Grand Teton National Park. The 2006 NPS Management Policies' section 4.4.1.1 (Plant and Animal Population Management Principles) states that the NPS will maintain all native plant and animal species and their habitats inside parks. In addition, these policies state that ''the (National Park) Service will work with other land managers to encourage the conservation of the populations and habitats of these species outside parks whenever possible'' (NPS 2006, p. 43). The implementation of previously described policies should afford some protection to northern leatherside chub. Available information indicates that NPS statutes, regulations, and management policies adequately reduce impacts to the species.

The NEPA provides authority for the Service to assume a cooperating agency role for Federal projects undergoing evaluation for significant impacts to the human environment. This includes participating in updates to resource management plans. As a cooperating agency, we have the opportunity to provide recommendations to the action agency to avoid impacts or enhance conservation for northern leatherside chub and its habitat. For projects where we are not a cooperating agency, we often review proposed actions and provide recommendations to minimize and mitigate impacts to fish and wildlife resources. Acceptance of our NEPA recommendations is at the discretion of the action agency. The BLM and USFS land management practices are intended to ensure avoidance of negative effects to species whenever possible, while also providing for multiple-use mandates; therefore, maintaining or enhancing northern leatherside chub habitat is considered in conjunction with other agency priorities. We determine that NEPA and its implementing regulations and policies are currently adequately reducing impacts to northern leatherside chub.

The CWA is the primary legislation protecting water quality in U.S. aquatic habitats and establishes a process to identify and clean polluted waters. Section 303(d) of the CWA requires each State to develop a list of impaired waters, defined as a waterbody that does not meet certain water-quality uses (CWA 1977, entire). States must evaluate all existing and readily available information in developing their lists of impaired waters (EPA 2002, p. 9). There are several established water quality uses including drinking water supply, swimming, and aquatic life support (EPA 2002, p. 11). To meet the aquatic life support use, a waterbody must provide suitable habitat for a balanced community of aquatic organisms (EPA 2002, p. 11). Best professional judgment, along with numeric and narrative criteria created by the State and the EPA, is considered when evaluating the ability of a water body to serve its uses.

Northern leatherside chub population areas contain wetland and stream habitats, and section 404 of the CWA regulates fill in wetlands and streams that meet certain jurisdictional requirements. Activities that result in fill of jurisdictional wetland and stream habitat require a section 404 permit. We can review permit applications and provide recommendations to avoid and minimize impacts and to implement conservation measures for fish and wildlife resources, including the northern leatherside chub. However, incorporation of Service recommendations into section 404 permits is at the discretion of the U.S. Army Corps of Engineers (Corps). In addition, not all activities in wetlands or streams involve fill and not all wetlands or streams fall under the jurisdiction of the Corps. Regardless, earlier in this finding we evaluated threats to northern leatherside chub habitat where fill of wetlands or streams may occur, including mining and oil and gas development. We found no information indicating that impacts from stream or wetland fill are acting on the species to the point that the species itself may be at risk, nor is it likely to become so.

Summary of Factor D

Available information indicates that land management regulatory mechanisms are sufficiently minimizing and mitigating potential threats from land development to extant northern leatherside chub populations. The BLM and USFS continue to work with permittees on Federal lands to implement beneficial land use practices and minimize impacts. The BLM and USFS have provided protective mechanisms for conservation agreement and sensitive species, including the northern leatherside chub, which can minimize impacts from oil and gas drilling, mining, and grazing. We have the ability to comment on NEPA evaluations for other projects on BLM and USFS lands that may impact the northern leatherside chub. The NPS mandate to conserve wildlife and leave it unimpaired has allowed NPS lands to currently be adequately and sufficiently protected and will sufficiently minimize future threats on NPS-managed lands. As discussed above, the BLM, USFS, and NPS are also signatories to the ''Rangewide Conservation Agreement and Strategy for Northern Leatherside'', the goals of which are to ensure the long-term persistence of the northern leatherside chub and to support the development of multi-State conservation efforts through coordinated conservation actions and regulatory consistency. As signatories to this conservation strategy these agencies are addressing issues related to the northern leatherside chub.

Although regulatory mechanisms are not in place to sufficiently protect the northern leatherside chub from local or large-scale water withdrawal and development in Wyoming and Nevada, projected development in these States should be minimal in the areas where northern leatherside chub occurs (see Factor A: Water Development for more information regarding water withdrawal and development). We found no information that inadequacy of existing regulatory mechanisms may act on this species to the point that the species itself may be at risk, nor is it likely to become so.

Factor E. Other Natural or Manmade Factors Affecting Its Continued Existence

Natural and manmade threats to northern leatherside chub include: (1) Hybridization; (2) climate change; and (3) cumulative effects of all activities that may impact the species.

Hybridization

Hybridization can be a concern for some fish populations. An introgressed population can result when a genetically similar species is introduced into or invades northern leatherside chub habitat, the two species interbreed (i.e., hybridize), and the resulting hybrids survive and reproduce. If the hybrids backcross with one or both of the parental species, genetic introgression occurs (Schwaner and Sullivan 2009, p. 198). Continual introgression can eventually lead to the loss of genetic identity of one or both parent species, thus resulting in a ''hybrid swarm'' consisting entirely of individual fish that often contain variable proportions of genetic material from both of the parental species (Miller and Behnke 1985, p. 514).

Hybridization is commonly associated with disturbed environments (Helfman 2007, p. 215) because in natural, complex habitats, different species are able to reproduce separately by using different habitat types. Additionally, disturbances allow dispersal of species to habitats where they did not naturally occur. For example, water diversions and transfers may allow isolated habitat that previously held distinctly separate populations (allopatric) to overlap habitats (sympatric) and present an opportunity for hybridization to occur.

We are aware of a historical record that fish collections from Sulphur Creek in the Bear River subregion contained redside shiner x leatherside chub hybrids and that it is possible for leatherside chub to hybridize with speckled dace (Baxter and Stone 1995, pp. 70–71); however, we do not know how this determination was made (i.e., morphologically or via genetic analysis), or when these fish were collected. Northern leatherside chub populations coexist with speckled dace in La Chapelle, Mill, Sulphur, and Yellow Creeks, where both species are native to these drainages (Amadio *et al.* 2009, p. 1). Examination of northern leatherside chub from these drainages using morphological characteristics suggested that populations in La Chapelle Creek and Yellow Creek were genetically pure, but that specimens from the other two creeks exhibited intermediate morphological characteristics of both species, thereby suggesting potential hybridization. However, subsequent genetic analysis determined that there was no evidence of genetic mixing; thus we conclude that hybridization is not occurring in these drainages at significant levels (Amadio *et al.* 2009, entire). Although no other hybridization-specific studies were conducted on northern leatherside chub, other recent genetic investigations have not documented hybridization in extant northern leatherside chub populations (Johnson and Jordan 2000, entire; Johnson *et al.* 2004, entire).

In summary, recent examination of northern leatherside chub from habitats where potential northern leatherside chub hybrids were historically found has determined that hybridization is not present. Genetically pure northern leatherside chub still occur at these sites, and no new evidence of hybridization has surfaced. Despite the historical supposition of hybridization in some localized areas, there are no known new occurrences. We found no information that hybridization may act on this species to the point that the species itself may be at risk, nor is it likely to become so.

Climate Change

Stream conditions across the range of the northern leatherside chub are shaped by regional climatic conditions, primarily precipitation and temperature. Water and precipitation is limited in this arid region. Seasonally, conditions range from cold, snowy winters to hot, dry summers. Annually, extended oscillations between wet and dry periods also are common (Barnett *et al.* 2008, p. 1080). Hydrological patterns are dominated by high-elevation snow accumulation that subsequently supports spring runoff and groundwater recharge (Haak *et al.* 2010, p. 1). Northern leatherside chub evolved in this arid ecosystem, demonstrating their ability to withstand historical climatic variability, including drought conditions.

Predictions of future climatic conditions can no longer rely on analysis of past climatic trends, but must instead take into account predicted global climate change. Both the Intergovernmental Panel on Climate Change and the U.S. Global Climate Change Program conclude that changes to climatic conditions, such as temperature and precipitation regimes, are occurring and are expected to continue in western North America over the next 100 years (Parson *et al.* 2000, p. 248; Smith *et al.* 2000, p. 220; Solomon *et al.* 2007, p. 70, Table TS.76; Trenberth *et al.* 2007, pp. 252–253, 262–263). Climate variability adds uncertainty to predictions of water availability in stream systems, both in volume of water and timing of flows (Haak *et al.* 2010, p. 2). Therefore, it is important to consider how future climatic conditions may impact northern leatherside chub.

In western North America, surface warming and precipitation changes resulting in reduced mountain snowpack (Trenberth *et al.* 2007, p. 310; Mote *et al.* 2005 and Regonda *et al.* 2005, cited in Vicuna and Dracup 2007, p. 330) and a trend toward earlier snowmelt (Stewart *et al.* 2004, pp. 217, 219, 223) are climatic conditions most likely to impact stream ecosystems (Field *et al.* 2007, p. 619; EPA 2008, p. 11; American Fisheries Society 2010, p. 7). Less snow accumulation, along with earlier and more rapid snowmelt, can affect physical ecosystem properties in many ways, such as: Reducing aquifer recharge and groundwater supplies for consistent stream flows; increased water temperatures associated with lower summer stream flows; increased spring flooding from rain storms onto snowpack; increased wildfire risk from earlier snowmelt and drier vegetation;

and prolonged drought conditions (American Fisheries Society 2010, p. 11; many citations in Haak *et al.* 2010, p. 2). The alterations, especially reduction in consistent flows and increased water temperatures, also will have a myriad of biotic ecosystem effects, including: Reduction in available aquatic habitat and resources (increasing competition, while simultaneously reducing carrying capacity); alteration of migration and reproduction patterns; shifting species assemblages as suitable conditions move geographically; and increased nonnative species invasions (Helfman 2007, pp. 185–186; American Fisheries Society 2010, p. 11). Out of this large set of impacts, we will analyze the following potential impacts of climate change on northern leatherside chub because they are the most likely to negatively impact the species: Increased chance of extreme events (spring floods, severe wildfire, and prolonged drought); shift in distribution to higher elevation or latitude; and upstream shift of nonnative trout.

Increased Chance of Extreme Events

The first potential impact from climate change is increased likelihood of extreme events, such as spring floods, wildfire, and drought. Because northern leatherside chub populations mostly occur in small, localized areas and in smaller streams, a localized extreme event that alters stream conditions to lethal levels could extirpate a local population isolated or fragmented from other populations. Furthermore, isolated populations are at a greater risk of extirpation because recolonization following the event may be precluded (American Fisheries Society 2010, p. 9). The three most likely extreme events that would affect northern leatherside chub are atypical spring floods, severe wildfire, and prolonged drought. Northern leatherside chub seemingly have a tolerance of short-term, extreme environmental conditions (Belk and Johnson 2007, pp. 70–71), suggesting the species may be able to adapt to short-term disturbances resulting from climate change.

Uncharacteristic flooding may be a large stressor for fish species (Williams *et al.* 2009, p. 533; American Fisheries Society 2010, p. 7), especially small-bodied individuals (Harvey 1987, p. 851) like the northern leatherside chub. A flood event could wash individuals from local habitats, carrying them downstream to unsuitable habitats, such as reservoirs, mainstem channels, or even onto upland habitat, or could cause direct mortality (Poff 2002, p. 1500). Even if individuals survived, they may not be able to return to their native location if they were carried over fish barriers. As an example of this for closely related minnow species, biologists hypothesize that a monsoonal flood event in Clay Creek, a tributary to the East Fork of the Sevier River, may be responsible for the extirpation of aquatic populations, including the southern leatherside chub (Golden *et al.* 2009, p. 2; Borden and Cox 2010, p. 2). The likelihood of entrainment during flood conditions is reduced because canals carry less percentage of the river into the canal and during high flows, most canals are closed to preserve infrastructure and fields likely have enough water.

All species of native fish could be impacted by wildfire effects, elevating the topic to a primary concern for western forest ecosystem management (Rinne 2004, p. 151). Severe wildfires (complete denuding of landscape and death of all vegetation) can alter stream systems both instantaneously (ash inputs changing water chemistry or flames heating stream water) and chronically (debris and sediment inputs from denuded uplands, or water warming from lack of riparian vegetation) (multiple citations in American Fisheries Society 2010, p. 9). These changes cannot only cause fish mortality and population loss, but also have long-term effects on the food web through macroinvertebrate mortality (Rinne 1996, p. 653). Severe wildfire events have caused documented local extirpation events for multiple salmonid populations in the western United States (Rinne 1996, p. 653; 2004, p. 151), but in areas where nearby source populations exist, recolonization has occurred (Howell 2006, p. 983). We expect similar responses from northern leatherside chub because severe wildfires often produce conditions that are more extreme than the occupied habitats discussed in previous sections, such as under Factor A: Grazing. Additional impacts arise from fire suppression efforts that can create physical disturbances (increased erosion and overland flow, temporary reduction or cessation of flows in small streams when drafting or dipping water (Backer *et al.* 2004, p. 939, Table 1), or chemical disturbances (commonly used fire retardants and suppressant foams are toxic to aquatic species)) (Gaikowski *et al.* 1996, p. 252; Buhl and Hamilton 2000, p. 408; McDonald *et al.* 1996, p. 63). It is possible that a severe wildfire could threaten northern leatherside chub through both immediate and long-term effects.

Northern leatherside chub are resilient to moderate wildfire conditions (charred landscape but some vegetation remains). For example, a 1991 fire centered in the Trail Creek portion of the Jackknife Creek subwatershed (Snake River subregion) did not extirpate the population (Isaak and Hubert 2001, p. 27). Five years after the fire, individuals were found in multiple locations throughout the Jackknife Creek subwatershed, indicating population persistence (Isaak and Hubert 2001, pp. 26–27). It is worth noting that the entire subwatershed was not burned and that individuals caught in 1996 may be emigrants from a nearby population from the tributary Squaw Creek. Regardless, northern leatherside chub were found to be persisting in the still degraded post-fire Trail Creek area, with stream temperatures often exceeding 23 °C (73 °F) in the summer because of a lack of riparian cover (Isaak and Hubert 2001, p. 27).

Prolonged drought is the third category of extreme event we considered as a potential threat to northern leatherside chub. Prolonged drought alters stream conditions by reducing available water, leading to diminished habitat and habitat of lower quality (e.g., increased temperature, decreased oxygen) (Helfman 2007, p. 184). The presence of suitable water conditions in streams is fundamentally linked to the distribution, reproduction, fitness, and survival of fish species (Helfman 2007, p. 97; American Fisheries Society 2010, p. 7). Less available habitat space causes niches to overlap, increasing predatory pressure on prey species and competitive pressures throughout the food web, and causing an overall reduction in carrying capacity and supported biomass (Helfman 2007, p. 13). Northern leatherside chub diets overlap with many other native fish species (Bell and Belk 2004, p. 414), and they are a prey species for others, demonstrating that these biotic effects could potentially arise.

Prolonged drought also has a human component, as drought conditions generally lead to increased irrigation demands on stream and groundwater resources (Alley *et al.* 1999, pp. 20–21). This suggests that human demands could exacerbate natural drought conditions created by climate change (EPA 2008, p. 12). Additionally, within the Bear River subbasin, irrigation canals might take larger percentages of the river flow in low-flow years, which would likely entrain a correspondingly higher percentage of fish, including northern leatherside chub (Gale *et al.* 2008, p. 1546), but the relationship may not be one to one (Hanson 2001, p. 331).

All of these disturbance events currently occur in localized areas across the species' range. Nevertheless, future climate conditions may increase the severity or frequency of the events (EPA 2008, p. 11). To test this possibility, the USGS and Trout Unlimited recently analyzed how predicted future climatic conditions would alter the risk of extreme floods, wildfire, and drought for all subbasins containing inland native trout species. With this information they produced risk classifications applied at the subwatershed scale (Haak *et al.* 2010, pp. 1–16; Service 2011, pp. 1–4). Because the risk of these three events are species-independent (results are based on climate, elevation, etc., and not species characteristics), and because northern leatherside chub distribution overlaps with Yellowstone, Bonneville, and Colorado River cutthroat trout, the risk models created in this report can be applied to all extant northern leatherside chub populations.

Researchers used existing broad-scale data, combined with local drainage characteristics, to describe potential future disturbance regimes (Haak *et al.* 2010, pp. 5–16). Using their results, we determined potential risk to northern leatherside chub populations from these disturbances. All extant northern leatherside chub populations had a low risk of extreme winter flooding except the three populations in the Goose Creek subbasin, which had moderate risk resulting from a future forecasted transition from snow to snow/rain mix (Table 10) (Haak *et al.* 2010, pp. 9, 30, 59; Service 2011, pp. 1–4). Rangewide, all northern leatherside chub populations occur in watersheds assessed at high risk for increased wildfires because they inhabit elevational bands that are expected to have earlier snowmelt and subsequent longer fire seasons, except the Goose Creek subbasin (Table 10) (Haak *et al.* 2010, pp. 12, 30, 59; Service 2011, pp. 1–4). However, wildfire effects will likely be local in scale and we expect northern leatherside chub can either retreat to habitat refuges during a fire, or recolonize extirpated areas after a fire has ended because most populations have a recolonization potential. All populations except for the Pacific Creek population (moderate risk from higher elevation and higher mean precipitation) were at a high risk for future forecasted drought impacts (Table 10) (Haak *et al.* 2010, pp. 15, 31, 60; Service 2011, pp. 1–4).

TABLE 10—RISK ASSESSMENT OF NORTHERN LEATHERSIDE CHUB POPULATIONS [HAAK *et al.* 2010]

National hydrography dataset subbasin	Population	Risks classifications from USGS climate change paper		
		Flood	Wildfire	Drought
Upper Bear	Upper Mill/Deadman Creeks	Low	High	High.
	Upper Sulphur/La Chapelle Creeks	Low	High	High.
	Yellow Creek	Low	High	High.
	Upper Twin Creek	Low	High	High.
	Rock Creek	Low	High	High.
Central Bear	Dry Fork Smiths Fork	Low	High	High/Moderate.
	Muddy Creek	Low	High	High.
Snake Headwaters	Pacific Creek	Low	High	Moderate.
Salt River	Jackknife Creek	Low	High	High.
Goose Creek	Trapper Creek	Moderate	Low	High.
	Beaverdam Creek	Moderate/High	Low	High.
	Trout Creek	Moderate/High	Low	High.
Upper Green River/Slate Creek	North Fork Slate Creek	Low	High	High.
Blacks Fork	Upper Hams Fork	Low	High	High/Moderate.

This analysis demonstrates that most subwatersheds harboring northern leatherside chub (11 of 14) are at risk for increased wildfire impacts. Even more strikingly, all extant northern leatherside chub populations are at risk for increased drought conditions because local conditions will not mitigate predicted regional extreme drought. However, most northern leatherside chub populations (11 of 14) are not at risk for increased flooding caused by earlier rain on snow events.

Based on this analysis we conclude that enhanced spring flooding is not a threat to populations of northern leatherside chub because only a fraction of the populations are at risk from this factor. Northern leatherside chub populations assessed at moderate to moderate/high risk of spring flooding occur in the Goose Creek subbasin, Snake River subregion. Spring flooding could be a factor or become a threat depending upon the magnitude of the flooding event, which could displace fish downstream into reservoir habitats where predation is a concern or strand individuals into unsuitable habitats or out of the water channel.

Although there is evidence that wildfire risks will increase, we conclude that wildfire also is not a substantial risk to the entire species, because wildfires and wildfire effects will likely be local in scale relative to the large, multi-state, widely distributed range of the species. Local wildfires may extirpate populations, but we expect northern leatherside chub can either retreat to habitat refuges during a fire, or recolonize extirpated areas after a fire has ended because most populations have a recolonization potential (see discussion under Factor A: Fragmentation and isolation section). We hypothesize that a similar mechanism took place in Jackknife Creek in the early 1990s, allowing the population to persist after a wildfire.

Increased drought is a predicted rangewide problem for northern leatherside chub populations (Table 10). While this species evolved in an arid region and dealt with historical drought conditions, human modifications to riverine systems for water consumption (irrigation diversions, reservoir construction and management, municipal water use, etc.) have greatly altered the natural hydrology over the past 200 years. Therefore, current conditions, including human water development, must be analyzed. An analysis of water development in extant population locations indicates that dewatering is not common in most populations, suggesting that these populations have elasticity to deal with lower water availability in the future. In addition, northern leatherside chub are documented to persist in degraded habitats, such as remnant pools, and seem to persist in short-term low water conditions (Belk and Johnson 2007, p.

71). Because of these adaptations to deal with harsh conditions, and their ability to shift habitats as drought conditions warrant, drought has a limited effect on the species rangewide. We found no information that drought may act on this species to the point that the species itself may be at risk, nor is it likely to become so.

Northern Leatherside Chub and Nonnative Trout Habitat Shifts

Large-scale climatic warming trends are expected to result in warmer water temperatures nationwide (EPA 2008, p. 8). Because water temperature is a keystone feature of fish community distribution, predicted changes are expected to negatively affect cold-water fisheries continent-wide and cool-water fisheries in the southern latitudes, while benefiting warm-water species continent-wide and cool-water species in the northern latitudes (Field *et al.* 2007, p. 631). Northern leatherside chub are adapted to warmer water temperatures, including seasonal water temperature changes associated with late summer baseflows in mid-elevation streams (Wilson and Belk 2001, p. 39; Belk and Johnson 2007, p. 71). As such, northern leatherside chub may not be as vulnerable to warming water trends as cold-water species such as brook trout.

Where suitable upstream habitats are available and stream gradient permits, we expect that northern leatherside chub populations can transition upstream, tracking suitable habitat conditions. Across the range of the species, most extant northern leatherside chub populations occur in mid-headwater reaches with upstream habitat often unoccupied by individuals. For example, for a few populations in the Bear River and Green River subregions, their upstream distribution is demarcated by the presence of brook trout or possibly cooler water temperatures, which are predicted to shift upstream and decline as water temperatures warm if forecasted climate change impacts occur (Field *et al.* 2007, p. 624).

If predicted water temperatures conditions change across the range of the northern leatherside chub, the distribution of other fish species will shift as well, including those that could impact northern leatherside chub (see discussion under Factor C: Predation). Low water temperatures are believed to currently restrict the distribution of brown trout (Sigler and Sigler 1996, p. 206), suggesting that region-wide warming water temperatures may benefit the species through increasing suitable upstream habitats. On the other hand, because rainbow trout are able to tolerate more wide-ranging water temperatures (Sigler and Sigler 1996, p. 184), their distribution may only moderately change.

Because brown trout are more tolerant of warmer waters than other trout species, increased stream temperatures as a result of climate change effects may allow brown trout populations to expand their range upstream and possibly impact three populations of northern leatherside chub, two in the central Bear River subbasin and one in the Salt River subbasin. For example, brown trout in lower Jackknife Creek are currently limited by cooler water temperatures and may be able to migrate (shift) upstream if increasing water temperatures result from climate change effects, as there are no physical barriers to movement. Although the Jackknife Creek leatherside chub population may be vulnerable to any future brown trout upstream re-distribution from warming waters, it is unclear how Jackknife Creek water temperatures will change, and how chub and brown trout will respond in terms of migration into currently unoccupied upstream and adjacent tributary habitats. Because northern leatherside chub currently occur in an approximately 13-km reach and at least two adjacent tributaries, it is highly unlikely that the species would be eliminated throughout this reach in the event brown trout redistributed upstream in response to warming water temperatures. Northern leatherside chub populations in the Dry Fork Smiths Fork or Muddy Creek (Bear River subregion) are not considered vulnerable to future impacts from downstream brown trout populations as a result of climate change, as existing fish passage barriers and degraded habitat conditions will likely inhibit their movement.

We expect that the distribution of existing rainbow trout populations will likely remain similar to today, or only change moderately because they are thermal generalists. Rainbow trout overlap with two extant northern leatherside chub populations, and any existing impacts are not likely to increase as a result of climate change.

Brook trout populations will likely be negatively impacted by climate change because they are a cold-water fish (Sigler and Sigler 1996, p. 212). We expect any future climate change effects will reduce brook trout abundance upstream of extant northern leatherside chub populations (i.e., brook trout occurrences that are not currently threatening the northern leatherside chub), which could benefit northern leatherside chub that may migrate upstream into suitable habitats no longer inhabited by brook trout.

We found no information that warming stream temperatures may act on this species to the point that the species itself may be at risk, nor is it likely to become so. Northern leatherside chub are adapted to warmer water temperatures, including seasonal water temperature changes associated with late summer baseflows in mid-elevation streams. Most populations occur in streams with currently upstream habitats that may become suitable as stream temperatures change, allowing populations to shift into currently unoccupied upstream or adjacent stream habitats. One northern leatherside chub population in Jackknife Creek may become vulnerable to future brown trout predation if brown trout redistribute upstream as a result of warming waters due to climate change, although it is unclear how Jackknife Creek water temperatures will change and how both chub and brown trout will respond in terms of migration into currently unoccupied upstream and adjacent tributary habitats.

Summary of Impacts of Climate Change

Because northern leatherside chub are able to survive in broad habitat conditions and tolerate warm water temperatures (Wilson and Belk 2001; Nannini and Belk 2006, p. 454), we believe that populations will be resilient to small-scale abiotic changes to habitat because of climate change (upstream habitat shift caused by temperature changes, etc.). We also believe there is adequate upstream habitat to facilitate upstream migration of populations in the face of warming stream temperatures.

Recent modeling efforts predict increased frequency of catastrophic events, especially increased wildfires and prolonged drought. We expect connected, large populations to weather these disturbances with natural demographic fluctuations. Wildfire impacts will likely take place on a small enough geographic scale to allow some portion of northern leatherside populations to survive, which will allow for recolonization and population expansion after the fire has receded and habitat has recovered. Prolonged or more frequent drought will likely occur on a larger scale. However, we expect northern leatherside chub to persist during these periods because individuals can survive in broad habitat conditions and are tolerant of low water levels. While the smaller, more isolated northern leatherside chub populations are at an increased risk from increased frequency of possible stochastic events associated with climate change, there is still uncertainty on how, when, or if, these impacts may occur.

Shifting distributions of nonnative trout also are not expected to create undue risk to the species. Only one population of northern leatherside chub in Jackknife Creek may be at increased risk from shifting nonnative trout; therefore, we believe the species as a whole is resilient to this threat. We found no information that climate change effects may act on this species to the point that the species itself may be at risk, nor is it likely to become so.

Cumulative Impacts

Some of the threats discussed in this finding can work in concert with one another to cumulatively create situations that will impact northern leatherside chub beyond the scope of each individual threat. For example, as discussed under Factor C: Predation, the impacts of nonnative trout are exacerbated by drought conditions because individual northern leatherside chub will be exposed to brown trout if their side channel habitats are eliminated. In the absence of drought conditions, northern leatherside chub can potentially persist in the presence of brown trout, albeit in low densities. Similarly, in the absence of brown trout, drought conditions are not a threat to northern leatherside chub because the species is adapted to withstand a broad range of habitat conditions including higher stream temperatures and low water levels. Because of this relationship, we will analyze the cumulative impact of drought (as a result of climate change), water development (human-caused water reduction), and nonnative trout presence.

We also analyze the relationship between population size, isolation, and potential threats. Dense, connected populations are able to withstand impacts more vigorously than small, isolated populations. Dense populations are able to lose individuals without a corresponding loss of the entire population, but small populations are vulnerable if even a few individuals are lost. Similarly, connected populations are more secure from threats because nearby populations can provide rescue effects (immigrants and recolonization). In contrast, isolated populations have no potential to be rescued, so local extirpation is likely permanent.

Drought, Water Development, and Nonnative Trout

As mentioned previously, when nonnative trout are present, drought conditions greatly intensify northern leatherside chub mortality risk. Five northern leatherside populations harbor nearby or resident populations of rainbow or brown trout (Table 7): Dry Fork Smiths Fork and Muddy Creeks in the Bear River subregion; Jackknife and Trapper Creeks in the Snake River subregion; and Upper Hams Fork in the Green River subregion. All five of these populations have either high or moderate-to-high risk of increased drought from climate change (Table 10); however, none of these five populations have experienced dewatering events in the past (Table 5), indicating that natural flow (not irrigation) conditions will drive the water supply for habitat.

Increased drought will not increase the risk of nonnative trout in the Dry Fork Smiths Fork or Muddy Creek populations because lower water conditions will only reduce the chance of brown trout invasion. As a result of decreased water supply, Muddy Creek habitat conditions will become even less suitable for trout and Dry Fork Smiths Fork will be even more isolated by culverts.

We believe that the northern leatherside chub populations in the Upper Hams Fork and Trapper Creek will become more impacted by the resident rainbow trout in drought conditions. However, the low density of rainbow trout and the high density of northern leatherside chub in the Upper Hams Fork do not put this population at risk of extirpation. The Trapper Creek northern leatherside chub population is less dense and could experience more of an impact from rainbow trout predation in drought conditions than Upper Hams Fork.

Under drought conditions as a result of climate change, habitat conditions in the Jackknife Creek subwatershed may facilitate upstream movement by brown trout. Such warming conditions will initially be within the tolerable range of northern leatherside chub, but may expand the availability of brown trout habitat. However, with the possible exception of the northern leatherside chub population in Jackknife Creek, the species should be resilient to small-scale abiotic changes to habitat because of climate change (upstream habitat shift caused by temperature changes, etc.) and there is likely adequate upstream and nearby tributary habitats to adapt to under future drought conditions.

Drought and Water Quality

Two northern leatherside chub populations that occur in streams listed as 303(d) water quality impaired (Beaverdam and Trapper Creeks) may be at increased risk due to future drought severity effects (Table 10). The water quality impairments in these streams that would likely impact northern leatherside chub (elevated sediment and phosphorous, and low dissolved oxygen) would be exacerbated under lower flow conditions that result from future drought conditions. However, because there is no current information on how impaired water quality may be impacting existing northern leatherside chub populations, we cannot predict how future drought conditions will effect the species' habitats or water quality.

Population Fragmentation and Isolation in Relation to Other Threats

As demonstrated in the preceding section, impacts that do not threaten northern leatherside chub independently may work together and have substantial, cumulative impacts. In this analysis, we will analyze the cumulative impacts to populations and the species as a whole, paying particular attention to population isolation and fragmentation.

In the preceding analysis, we determined that 7 of 14 northern leatherside chub populations were isolated, and 6 of 14 contained only a single documented occurrence of the species (see Factor A discussion and Table 6). Because 3 populations were both isolated and contained a single occurrence, the remaining 11 populations were considered sufficiently resilient in terms of population size and distribution (connected to other occurrences or populations) and only minimally impacted from the previously analyzed threats and, therefore, not at increased vulnerability from various threat factors due to isolation and fragmentation.

Summary of Factor E

Recent examination of northern leatherside chub from habitats where suspected hybrids were historically found has determined that hybridization is not present. Therefore, with no known instances of hybridization, we conclude that hybridization is not a threat to northern leatherside chub.

Projected impacts from future climate change effects will likely impact all northern leatherside chub populations to some degree, although the synergistic effect of these impacts with identified and potential threats are uncertain. Because stable, reproducing northern leatherside chub populations occur at many locations where degraded habitat conditions exist, their continued persistence and successful reproduction demonstrates that they have some level of tolerance for less than optimal environmental conditions. We found no information that other natural or manmade factors affecting its continued existence may act on this species to the point that the species itself may be at risk, nor is it likely to become so.

Finding

As required by the Act, we considered the five factors in assessing whether the northern leatherside chub (*Lepidomeda copei*) is endangered or threatened throughout all or a significant portion of its range. We examined the best scientific and commercial information available regarding the past, present, and future threats faced by the northern leatherside chub. We reviewed the petition, information available in our files, other available published and unpublished information, and we consulted with recognized northern leatherside chub experts, other Federal and State agencies, and university researchers. We also prepared a white paper that analyzed specific issues to the species. In considering what factors might constitute threats, we must look beyond the mere exposure of the species to the factor to determine whether the species responds to the factor in a way that causes actual impacts to the species. If there is exposure to a factor, but no response, or only a positive response, that factor is not a threat. If there is exposure and the species responds negatively, the factor may be a threat and we then attempt to determine how significant a threat it is. If the threat is significant, it may drive or contribute to the risk of extinction of the species such that the species warrants listing as endangered or threatened as those terms are defined by the Act. This does not necessarily require empirical proof of a threat. The combination of exposure and some corroborating evidence of how the species is likely impacted could suffice. The mere identification of factors that could impact a species negatively is not sufficient to compel a finding that listing is appropriate; we require evidence that these factors are operative threats that act on the species to the point that the species meets the definition of endangered or threatened under the Act.

Northern leatherside chub are a small, mid-elevation fish endemic to streams within the Bear River, Upper Green River, and Upper Snake River Basins. The range of the northern leatherside chub has declined over the past 50 years, and there are currently 14 extant populations spread over the Bear (7), Snake (5) and Green (2) River subregions. The species evolved in an arid ecosystem characterized by extreme seasonal and annual changes in physical conditions.

The most widely distributed, relatively large populations occur in the Bear River subregion. Most populations in the Bear River subregion are largely free of threats (Upper Mill/Deadman Creeks), contain multiple populations, can easily interact (Upper Twin Creek and Rock Creek), and include relatively high-density populations (Upper Mill/Deadman Creeks, Yellow Creek, Dry Fork Smiths Fork, Muddy Creek, Rock Creek, and Upper Twin Creek). As a result, we concluded that the size, connectedness, and stability of the Bear River populations are sufficient to ensure the long-term persistence of the species as a whole. Although less monitoring and collection information is available to characterize northern leatherside chub populations within the Snake River subbasin, most extant populations in the Snake River subbasin are discontinuous from other populations and have relatively low population numbers. Three of five Snake River populations have one or more factors affecting each population, primarily impaired water quality and nonnative trout. These and other factors were not considered significant or imminent. We do not fully understand how these current or potential threats are impacting the species, and it is believed that northern leatherside chub tolerate some level of degraded or short-term, extreme conditions. Although the isolation of some Snake River populations likely increases their vulnerability to the effects of identified threats, these threats do not currently or in the foreseeable future pose a substantial risk to species rangewide.

When evaluating the potential impact to northern leatherside chub and their habitat from future climate change effects, it is likely that warming water temperatures predicted to occur will likely benefit the species, especially in those stream systems with currently unoccupied habitats upstream. The species is tolerant of short-term extreme environmental conditions, suggesting the species may be able to survive some of the shorter-term disturbances from climate change. Because of the uncertainty associated with future climate change predictions, the synergistic effect of future climate change scenarios, with identified or potential threats on stream systems where the northern leatherside chub occurs, are unknown.

Based on our review of the best available scientific and commercial information pertaining to the five factors, we find that the threats are not of sufficient imminence, intensity, or magnitude to indicate that the northern leatherside chub is in danger of extinction (endangered), or likely to become endangered within the foreseeable future (threatened), throughout its range. Therefore, we find that listing the northern leatherside chub as an endangered or threatened species throughout its range is not warranted at this time.

Significant Portion of the Range

Having determined that the northern leatherside chub is not endangered or threatened throughout its range, we must next consider whether there are any significant portions of the range where the northern leatherside chub is in danger of extinction or is likely to become endangered in the foreseeable future.

The Act defines ''endangered species'' as any species which is ''in danger of extinction throughout all or a significant portion of its range,'' and ''threatened species'' as any species which is ''likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.'' The definition of ''species'' is also relevant to this discussion. The Act defines ''species'' as follows: ''The term 'species' includes any subspecies of fish or wildlife or plants, and any distinct population segment [DPS] of any species of vertebrate fish or wildlife which interbreeds when mature.'' The phrase ''significant portion of its range'' (SPR) is not defined by the statute, nor addressed in our regulations: (1) The consequences of a determination that a species is either endangered or likely to become so throughout a significant portion of its range, but not throughout all of its range; or (2) what qualifies a portion of a range as ''significant.''

Two recent district court decisions have addressed whether the SPR language allows the Service to list or protect less than all members of a defined ''species'': *Defenders of Wildlife* v. *Salazar,* 729 F. Supp. 2d 1207 (D. Mont. 2010), concerning the Service's delisting of the Northern Rocky Mountain gray wolf (74 FR 15123, April. 2, 2009); and *WildEarth Guardians* v. *Salazar,* 2010 U.S. Dist. LEXIS 105253 (D. Ariz. Sept. 30, 2010), concerning the Service's 2008 finding on a petition to list the Gunnison's prairie dog (73 FR 6660, February. 5, 2008). The Service had asserted in both of these determinations that it had authority, in effect, to protect only some members of a ''species,'' as defined by the Act (i.e., species, subspecies, or DPS), under the Act. Both courts ruled that the determinations were arbitrary and capricious on the grounds that this approach violated the plain and unambiguous language of the Act. The courts concluded that reading the SPR language to allow protecting only a portion of a species' range is inconsistent with the Act's definition of ''species.'' The courts concluded that once a determination is made that a species (i.e., species, subspecies, or DPS) meets the definition of ''endangered species'' or ''threatened species,'' it must be placed on the list in its entirety and the Act's protections applied consistently to all members of that species (subject to modification of protections through special rules under sections 4(d) and 10(j) of the Act).

Consistent with that interpretation, and for the purposes of this finding, we interpret the phrase ''significant portion of its range'' in the Act's definitions of ''endangered species'' and ''threatened species'' to provide an independent basis for listing; thus there are two situations (or factual bases) under which a species would qualify for listing: A species may be endangered or threatened throughout all of its range; or a species may be endangered or threatened in only a significant portion of its range. If a species is in danger of extinction throughout an SPR, it, the species, is an ''endangered species.'' The same analysis applies to ''threatened species.'' Based on this interpretation and supported by existing case law, the consequence of finding that a species is endangered or threatened in only a significant portion of its range is that the entire species will be listed as endangered or threatened, respectively, and the Act's protections will be applied across the species' entire range.

We conclude, for the purposes of this finding, that interpreting the SPR phrase as providing an independent basis for listing is the best interpretation of the Act because it is consistent with the purposes and the plain meaning of the key definitions of the Act; it does not conflict with established past agency practice (i.e., prior to the 2007 Solicitor's Opinion), as no consistent, long-term agency practice has been established; and it is consistent with the judicial opinions that have most closely examined this issue. Having concluded that the phrase ''significant portion of its range'' provides an independent basis for listing and protecting the entire species, we next turn to the meaning of ''significant'' to determine the threshold for when such an independent basis for listing exists.

Although there are potentially many ways to determine whether a portion of a species' range is ''significant,'' we conclude, for the purposes of this finding, that the significance of the portion of the range should be determined based on its biological contribution to the conservation of the species. For this reason, we describe the threshold for ''significant'' in terms of an increase in the risk of extinction for the species. We conclude that a biologically based definition of ''significant'' best conforms to the purposes of the Act, is consistent with judicial interpretations, and best ensures species' conservation. Thus, for the purposes of this finding, and as explained further below, a portion of the range of a species is ''significant'' if its contribution to the viability of the species is so important that without that portion, the species would be in danger of extinction.

We evaluate biological significance based on the principles of conservation biology using the concepts of redundancy, resiliency, and representation. *Resiliency* describes the characteristics of a species and its habitat that allow it to recover from periodic disturbance. *Redundancy* (having multiple populations distributed across the landscape) may be needed to provide a margin of safety for the species to withstand catastrophic events. *Representation* (the range of variation found in a species) ensures that the species' adaptive capabilities are conserved. Redundancy, resiliency, and representation are not independent of each other, and some characteristic of a species or area may contribute to all three. For example, distribution across a wide variety of habitat types is an indicator of representation, but it may also indicate a broad geographic distribution contributing to redundancy (decreasing the chance that any one event affects the entire species), and the likelihood that some habitat types are less susceptible to certain threats, contributing to resiliency (the ability of the species to recover from disturbance). None of these concepts is intended to be mutually exclusive, and a portion of a species' range may be determined to be ''significant'' due to its contributions under any one or more of these concepts.

For the purposes of this finding, we determine if a portion's biological contribution is so important that the portion qualifies as ''significant'' by asking whether *without that portion,* the representation, redundancy, or resiliency of the species would be so impaired that the species would have an increased vulnerability to threats to the point that the overall species would be in danger of extinction (i.e., would be ''endangered''). Conversely, we would not consider the portion of the range at issue to be ''significant'' if there is sufficient resiliency, redundancy, and representation elsewhere in the species' range that the species would not be in danger of extinction throughout its range if the population in that portion of the range in question became extirpated (extinct locally).

We recognize that this definition of ''significant'' (a portion of the range of a species is ''significant'' if its contribution to the viability of the species is so important that without that portion, the species would be in danger of extinction) establishes a threshold that is relatively high. On the one hand, given that the consequences of finding a species to be endangered or threatened in an SPR would be listing the species throughout its entire range, it is important to use a threshold for ''significant'' that is robust. It would not be meaningful or appropriate to establish a very low threshold whereby a portion of the range can be considered ''significant'' even if only a negligible increase in extinction risk would result from its loss. Because nearly any portion of a species' range can be said to contribute some increment to a species' viability, use of such a low threshold would require us to impose restrictions and expend conservation resources disproportionately to conservation benefit: Listing would be rangewide, even if only a portion of the range of minor conservation importance to the species is imperiled. On the other hand, it would be inappropriate to establish a threshold for ''significant'' that is too high. This would be the case if the standard were, for example, that a portion of the range can be considered ''significant'' only if threats in that portion result in the entire species' being currently endangered or threatened. Such a high bar would not give the SPR phrase independent meaning, as the Ninth Circuit held in *Defenders of Wildlife* v. *Norton,* 258 F.3d 1136 (9th Cir. 2001).

The definition of ''significant'' used in this finding carefully balances these concerns. By setting a relatively high threshold, we minimize the degree to which restrictions will be imposed or resources expended that do not contribute substantially to species conservation. But we have not set the threshold so high that the phrase ''in a significant portion of its range'' loses independent meaning. Specifically, we have not set the threshold as high as it was under the interpretation presented by the Service in the *Defenders* litigation. Under that interpretation, the portion of the range would have to be so important that current imperilment there would mean that the species would be *currently* imperiled everywhere. Under the definition of ''significant'' used in this finding, the portion of the range need not rise to such an exceptionally high level of biological significance. (We recognize that if the species is imperiled in a portion that rises to that level of biological significance, then we should conclude that the species is in fact imperiled throughout all of its range, and that we would not need to rely on the SPR language for such a listing.) Rather, under this interpretation we ask whether the species would be endangered everywhere without that portion, *i.e.,* if that portion were completely extirpated. In other words, the portion of the range need not be so important that even the species being in danger of extinction in that portion would be sufficient to cause the species in the remainder of the range to be endangered; rather, the *complete extirpation* (in a hypothetical future) of the species in that portion would be required to cause the species in the remainder of the range to be endangered.

The range of a species can theoretically be divided into portions in an infinite number of ways. However, there is no purpose to analyzing portions of the range that have no reasonable potential to be significant or to analyzing portions of the range in which there is no reasonable potential for the species to be endangered or threatened. To identify only those portions that warrant further consideration, we determine whether there is substantial information indicating that: (1) The portions may be ''significant,'' *and* (2) the species may be in danger of extinction there or likely to become so within the foreseeable future. Depending on the biology of the species, its range, and the threats it faces, it might be more efficient for us to address the significance question first or the status question first. Thus, if we determine that a portion of the range is not ''significant,'' we do not need to determine whether the species is endangered or threatened there; if we determine that the species is not endangered or threatened in a portion of its range, we do not need to determine if that portion is ''significant.'' In practice, a key part of the determination that a species is in danger of extinction in a significant portion of its range is whether the threats are geographically concentrated in some way. If the threats to the species are essentially uniform throughout its range, no portion is likely to warrant further consideration. Moreover, if any concentration of threats to the species occurs only in portions of the species' range that clearly would not meet the biologically based definition of ''significant,'' such portions will not warrant further consideration.

Decisions by the Ninth Circuit Court of Appeals in *Defenders of Wildlife* v. *Norton,* 258 F.3d 1136 (2001) and *Tucson Herpetological Society* v. *Salazar,* 566 F.3d 870 (2009) found that the Act requires the Service, in determining whether a species is endangered or threatened throughout a significant portion of its range, to consider whether lost historical range of a species (as opposed to its current range) constitutes a significant portion of the range of that species. While this is not our interpretation of the statute, we first address the lost historical range before addressing the current range.

Lost Historical Range

The available literature provides limited information on the historical distribution of northern leatherside chub. The type locality for the northern leatherside chub was discovered in 1881 from the mainstem Bear River near Evanston, Wyoming (Jordan and Gilbert 1881 in UDWR 2009, p. 39). The species is historically documented in portions of the Bear River and Upper Snake River subregions (Figure 1; Table 1). These historical collections demonstrate that the species existed over a wide geographic area from Idaho, to Wyoming, and into Utah.

Specifically, historical records (during the 1950s, 1960s, and 1970s) document the existence of individuals from three subbasins containing four locations that we consider populations today; one population in the Snake River subregion (Pacific Creek) and three populations in the Bear River subregion (Yellow Creek, Rock Creek, and Muddy Creek) (McAbee 2011, pp. 10, 19). Northern leatherside chub were also historically found in three subbasins that do not contain extant populations (McAbee 2011, p. 2). More recent investigations documented northern leatherside chub at two subbasins (Salt River and Goose Creek) within the Snake River subregion, thus adding four populations (Jackknife Creek, Trapper Creek, Beaverdam Creek, and Trout Creek) to the accepted historical range (McAbee 2011, p. 19).

The best scientific data allow us to document the historical existence of northern leatherside chub only at the subbasin scale. These historical data have more recently been compared to current distributional information to determine the presence of extant historical populations as explained above. We conclude that the historical range of northern leatherside chub included the following subbasins: Upper Bear River, Central Bear River, Logan River, Lower Bear River, Snake Headwaters, Salt River, Goose Creek, and Little Wood River.

Over the past 50 years, the range of the northern leatherside chub has declined, and the current range of the species is now contained in five of the eight documented historical subbasins (Wilson and Belk 2001, p. 36; Johnson *et al.* 2004, pp. 841–842; UDWR 2009, p. 24). Northern leatherside chub are likely extirpated from the Little Wood River in Idaho, where verified museum records exist, but recent collections failed to document any extant populations. Similarly, northern leatherside chub are likely extirpated from the Logan and Lower Bear Rivers in Utah and Idaho, where recent collections failed to document extant populations, and past collection records, while accepted as true, cannot be verified (McKay 2011, pers. comm.).

Although we acknowledge that there is some ambiguity in the historical and current ranges of northern leatherside chub (see Background: Distribution), we conclude that the species is extirpated from three of the eight historically occupied subbasins: The Logan River, Lower Bear River, and Little Wood River subbasins.

As described earlier (see Background: Distribution), despite the loss of the three historical populations, there remain 14 northern leatherside populations distributed across the Bear River, Upper Snake River, and Upper Green River subregions (see Figure 1). We now consider if the loss of the three historical populations (Logan River, Lower Bear River, and Little Wood River) is so important that individually or collectively this loss of range qualifies as ''significant'' by asking whether without these portions, the representation, redundancy, or resiliency of the species is so impaired that the species has an increased vulnerability to threats to the point that the overall species is in danger of extinction (see below for more information on justification for this assessment).

Although each of the three lost northern leatherside chub subbasins discussed above likely has features that make it unique, we determine that the historical populations were similar geographically and biologically to the current species' locations. For example, the species' potential spawning, feeding, and sheltering habitat in these locations was likely similar to current population locations (see Background: Life History, Habitat), and all occurred within subregions that are currently occupied (see Figure 1).

The loss of the three historically occupied subbasins in portions of the species' range likely resulted in a reduction in the species overall population, but the remaining populations are independent of these populations and do not rely on any of the lost population's habitat for life-history processes (e.g., spawning, feeding, sheltering). Furthermore, this potential reduction of reproductive output has not reduced the species' range of variation or adaptive capabilities to such a level that they would be in danger of extinction. Despite the loss of these three historically occupied subbasins, the resiliency of northern leatherside chub has not been appreciably impacted, and the species will continue to be able to recover from periodic disturbance and withstand catastrophic events in other parts of its range.

In summary, although the species is extirpated from three historically occupied subbasins, the species is found in five other historically occupied subbasins and two additional subbasins in the Upper Green River subregion and now comprises 14 populations in these subbasins. We conclude that these remaining 14 populations provide sufficient representation and redundancy of northern leatherside chub habitat throughout the species' current range such that northern leatherside chub is not in danger of extinction despite the loss of historical habitat. Thus, the lost historical range of northern leatherside chub does not constitute a significant portion of the range of the subspecies.

Current Range

After reviewing the potential threats throughout the range of northern leatherside chub, we determine that five of fourteen populations within the species' current range could be considered to have concentrated threats (see discussion under Factor A, Factor C, and Factor E). Below, we outline the elevated risk from potential threats found at the five populations and then assess whether these portions of the species' range may meet the definition of ''significant,'' that is, whether the contributions of these portions of the northern leatherside chub's range to the viability of the species is so important that without those portions, the species would be in danger of extinction.

The Dry Fork Smiths Fork population (Central Bear River subbasin) is isolated and likely contains only one occurrence of northern leatherside chub, making it vulnerable to a large-scale disturbance or stochastic event such as drought. The Pacific Creek population (Snake Headwaters subbasin) is similarly isolated (see discussion under Factor A: Fragmentation and Isolation of Existing Populations). In Jackknife Creek (Salt River subbasin), a brown trout population occurs downstream of the northern leatherside chub population (see discussion under Factor C: Predation). Although this population currently coexists with brown trout, there is the potential that a climate change-induced increase in water temperature could force a habitat shift, pushing predacious brown trout into core northern leatherside chub habitat (see discussion under Factor E: Climate Change). The Beaverdam Creek and Trapper Creek populations (Goose Creek subbasin) both occur in streams listed as 303(d) water quality impaired, although aquatic communities continue to persist (see discussion under Factor A: Water Quality). These populations could be at increased risk if future drought conditions occur (see discussion under Factor E: *Drought and Water Quality*). The Trapper Creek population co-occurs with rainbow trout and may be vulnerable to predation from this nonnative species (see discussion under Factor C: Predation and Table 7). Also, this population is isolated, making it vulnerable to a large-scale disturbance or stochastic event such as drought (see discussion under Factor A: Fragmentation and Isolation of Existing Populations and Table 6).

Because the northern leatherside chub faces elevated risk from potential threats at the five population locations discussed above, we next assess whether these portions of the species' range may meet the biologically based definition of ''significant.'' For these areas, we evaluate whether the populations' biological contributions are so important that individually or collectively this hypothetical loss of range would qualify as ''significant'' by asking whether *without that portion,* the representation, redundancy, or resiliency of the species would be so impaired that the species would have an increased vulnerability to threats to the point that the overall species would be in danger of extinction.

Although each of the five northern leatherside chub population locations discussed above likely has features that make it unique, we determine that they are similar geographically and biologically to other species' locations. For example, the species' spawning, feeding, and sheltering habitat is essentially the same at all population locations (see Background: Life History, Habitat). If the Dry Fork Smiths Fork, Pacific Creek, Jackknife Creek, Trapper Creek, and Beaverdam Creek populations could no longer support northern leatherside chub, other existing population locations could support the species' persistence. The remaining nine population locations are distributed within the species' current and historical range in the Bear River, Upper Snake River, and Upper Green River subregions (see Figure 1), and offer sufficient representation and redundancy of habitat and range such that northern leatherside chub would not be in danger of extinction if these five population locations were completely lost.

The loss of these five populations in portions of the species' range would directly result in a reduction in the species' overall population size, but the loss of individual populations would not cause a reduction in the local population size of any remaining population because each northern leatherside chub population is independent and does not rely on other population's habitat for life-history processes (e.g., spawning, feeding, sheltering). Also, the loss of the five populations would not reduce the species' range of variation or adaptive capabilities to such a level that they would be in danger of extinction. Without these five population locations, we expect that the resiliency of northern leatherside chub would not be appreciably impacted; the species would continue to be able to recover from periodic disturbances and withstand catastrophic events in other parts of its range.

In summary, despite having some locations of elevated risk to potential threats, we conclude that the portions of the northern leatherside chub's range where these threats occur are not significant portions of its range. Even if all of these population locations were extirpated at some time in the future, northern leatherside chub would persist at population locations not affected by these threats. As noted above, there is little that biologically distinguishes Dry Fork Smiths Fork, Pacific Creek, Jackknife Creek, Trapper Creek, and Beaverdam Creek from other population locations for northern leatherside chub. The existing, remaining population locations are distributed across the species' historical range in the Bear River, Upper Snake River, and Upper Green River subregions and provide adequate redundancy, resiliency, and representation for the species. Therefore, the five population locations (whether considered separately or combined) are not a ''significant'' portion of the species' range because their contribution to the viability of the species is not so important that the species would be in danger of extinction without those portions.

We find that northern leatherside chub is not in danger of extinction now, nor is it likely to become endangered within the foreseeable future throughout all or a significant portion of its range. Therefore, listing northern leatherside chub as endangered or threatened under the Act is not warranted at this time.

We request that you submit any new information concerning the status of, or threats to, northern leatherside chub to our Utah Ecological Services Field Office (see **ADDRESSES** section) whenever it becomes available. New information will help us monitor northern leatherside chub and encourage its conservation. If an emergency situation develops for the northern leatherside chub or any other species, we will act to provide immediate protection.

References Cited

A complete list of references cited is available on the Internet at *http://www.regulations.gov* and upon request from the Utah Ecological Services Field Office (see **ADDRESSES** section).

Authors

The primary authors of this notice are the staff members of the Utah and Idaho Ecological Services Field Offices.

Authority

The authority for this action is section 4 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*).

Dated: September 27, 2011.

Rowan Gould,

Acting Director, Fish and Wildlife Service.

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