

**Grotto Sculpin
(*Cottus specus*)**

**5-year Status Review:
Summary and Evaluation**



Photo of an adult Grotto Sculpin by Brad Pobst/Missouri Department of Conservation.

**U.S. Fish and Wildlife Service
Missouri Ecological Services Field Office
Columbia, Missouri**

STATUS REVIEW
Species reviewed: Grotto Sculpin (*Cottus specus*)

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STATUS REVIEW

Grotto sculpin/*Cottus specus*

GENERAL INFORMATION

Species: *Cottus specus*

Reviewers: Ashley Riedel, Missouri Ecological Services Field Office, 573-234-2132 ext. 404

Lead Regional or Headquarters Office: Laura Ragan, Midwest Regional Office, Bloomington, MN, 612-713-5292

Date of listing publication: September 25, 2013; effective October 25, 2013

FR citation(s): 78 FR 58938

Classification: Endangered

Critical habitat designation listing: 78 FR 58923

Methodology used to complete the review:

In accordance with section 4(c)(2) of the Endangered Species Act of 1973, as amended (Act), the purpose of a status review is to assess each threatened species or endangered species to determine whether its status has changed and if it should be classified differently or removed from the Lists of Threatened and Endangered Wildlife and Plants. The U.S. Fish and Wildlife Service (Service) evaluated the biology and status of the Grotto Sculpin to inform this status review.

The U.S. Fish and Wildlife Service's (USFWS) Missouri Ecological Services Field Office completed this review. New information considered in this review includes relevant information generated since the species' listing in 2013, which was the last most comprehensive review of the species. Information sources include the proposed and final rule listings (77 FR 59488; 78 FR 58938), peer reviewed scientific publications, final unpublished reports, as well as ongoing field survey results and information from qualified USFWS and State biologists. All literature and documents used for this review are on file at the Missouri Ecological Services Field Office in Columbia, Missouri. All recommendations resulting from this review are the result of thoroughly reviewing all available information on this species. A notice requesting information for this review was published on April 25, 2019 (84 FR 17420) and again on August 31, 2020 (85 FR 53842). The *notice* of review requested new scientific or commercial data and information that may have a bearing on the species' classification of endangered.

FR Notice citation announcing the species is under active review: April 25, 2019, FR 84, No. 80; August 31, 2020, FR 85, No. 169

Review History: No previous 5-year reviews have been completed for this species.

REVIEW ANALYSIS

Updated Information and Current Species Status:

The Grotto Sculpin is a troglomorphic (cave adapted) fish endemic to just five cave systems in two karst areas of Perry County, Missouri. These systems include Crevice Cave, Tom Moore aka Moore Cave, Mystery Cave, Rimstone River Cave and Running Bull Cave systems within Blue Spring Branch and Cinque Hommes Creek resurgence areas (Figure 1). These areas are characterized by thousands of sinkholes where consistent water flow, organic input, and connection to surface streams are sufficient such that seasonal migrations from underground streams to surface streams for the completion of the Grotto Sculpin's life cycle are possible (Burr et al. 2001; Fernholz et al. 2019; USFWS 2012; USFWS 2013). This species was first found to be unique in 2013 (Adams et al.) and was federally listed shortly thereafter due to its restricted range, population isolation, and documented mortality resulting from point-source pollution of above-ground waters that drained to underground aquatic habitats (USFWS 2013). Much of the current literature regarding the Grotto Sculpin's distribution, habitat requirements, and life history has been summarized in the proposed and final listing rules (September 27, 2012, 77 FR 59488; September 25, 2013, 78 FR 58938). New information believed to be relevant to assessing the species' status and understanding the status determination provided at the end of this review is summarized below.

Biology and Habitat:

Population demographics: Recent surveys by Fernholz et al. (2019) indicate population densities between 2015 and 2017 at Tom Moore, Mystery, and Running Bull caves to be similar to those found between 2005 and 2008 by Adams et al. (2008) (Table 1).

As of May, 2021, no total population estimates or general population trends have been calculated for the entirety of the Grotto Sculpin range. In addition, demographic features such as fecundity, age at mortality and mortality rates remain unknown; thus many demographic trends remain elusive. However, surveyors observed a gravid (egg carrying) female and milting (sperm secreting) male in October 2016 (Figure 2, Fernholz et al. 2019), outside of the predicted spawning seasons of late winter and early spring described in the species' listing rule (USFWS 2012; USFWS 2013). In addition, egg masses found during surveys between 2015 and 2017 ranged from as few as 15 to over 100 eggs per nest in Tom Moore Cave and Mystery Cave (Fernholz et al. 2019), whereas an average of approximately 200 eggs per nest was discovered in Mystery Cave in 1998 (Adams 2005; USFWS 2012).

Habitat: Between 2015 and 2016, Grotto Sculpin habitat in Tom Moore, Mystery, and Running Bull caves were investigated by Fernholz et al. (2019) to determine habitat availability and to record precise habitat characteristics (Table 2) and selection within these systems (F 3-5). Overall, adult Grotto Sculpin were most abundant in pools, or areas of the stream characterized by relatively deep depths and a slow current; this finding was regardless of which cave was sampled. However, juvenile sculpin in Tom Moore Cave were more abundant in riffles, or areas of the stream often agitated by rocks and characterized by relatively shallow depths and a quick current. Analysis revealed depth and substrate as the most important factors for modeling habitat

use in Running Bull Cave and Tom Moore Cave, while depth was the most important factor in Mystery Cave. Pools featuring slow velocity and cobble substrate were selected for most. However, analysis of habitat availability indicate a potential lack of pooled and cobbled areas, and thus an absence of vital refuge habitat throughout the surveyed areas (Fernholz et al. 2019).

Additional surveys conducted between December 2016 and March 2017 examined nest site habitat characteristics and found a preference for firm substrate (cobble and bedrock with a mean firmness of 1.13 cm) in moderately flowing, shallow streams with a mean velocity of 0.102 m/s and mean depth of 15.25 cm, relative to random sites. Nests generally consisted of egg masses under rocks of varied size with no significant preference for rock size outside of being large enough to cover both fish and egg masses (Figure 6). Cavities (hollow areas in or under rocks) with large openings were not used for nesting, and nesting activity was not observed in pebble, mud or silt substrates, or in water depths greater than 32 cm with velocities slower than 0.62 m/s or greater than 0.01 m/s. Interestingly, nest sites were found progressively upstream as the spawning period progressed, possibly due to increased agitation and thus higher oxygen availability in shallower waters there (Fernholz et al. 2019).

Threats Analysis (threats, conservation measures, and regulatory mechanisms):

Present or threatened destruction, modification or curtailment of its habitat or range: The most substantial threats to Grotto Sculpin come from present or threatened destruction, modification, or curtailment of its habitat. Major causes of these threats are outlined in the proposed and final rules (USFWS 2012; USFWS 2013), and continue to pose a risk to the species. The primary threats are water quality degradation and siltation. Since the species' listing, a preference for clean gravel and bedrock substrate has been observed (Joseph Gerken, pers. comm., 2021¹), and a lack of vital refuge habitat and absence of preferred habitat within three of the five inhabited caves has been identified (Fernholz et al. 2019). Although the source of such absence remains unknown, Fernholz et al. (2019) speculated landscape alterations associated with agriculture and the construction of impervious surfaces may be responsible due to agricultural runoff, soil erosion and general sediment pollution. Additional research indicates water degradation may also increase Grotto Sculpin susceptibility to parasitic infections due to increased stress and reduced health. This may be compounded by a lack of prey items in highly polluted areas and a concomitant increased reliance on cannibalism among Grotto Sculpin for sustenance (Day et al. 2014; Day et al. 2016).

Overutilization for commercial, recreational, scientific, or educational purposes: Although 229 Grotto Sculpin were collected for scientific investigations, all collections occurred prior to listing under the Endangered Species Act in 2013. Of these collections, all were used in research investigating parasite prevalence and approximately 67% were also used in genetic and morphologic analysis that resulted in the identification of species uniqueness for the Grotto Sculpin and informed the listing decision (Adams et al. 2013; Day et al. 2014). To minimize the need for future take for subsequent research, type material was deposited at Southern Illinois University Carbondale and paratype materials were deposited at the National Museum of Natural History (Adams et al. 2013). Additionally, parasite specimens were stored at the University of Central Arkansas (Day et al. 2014). There are no other records of collections involving lethal

¹ Joseph Gerken, researcher and instructor with Kansas State University, May 10, 2021

take for scientific, commercial, recreational or educational purposes following the species' identification and listing. Scientific collection not involving lethal take has been permitted under cooperative agreements through the Missouri Department of Conservation and the U.S. Fish and Wildlife Service, including visual surveys as well as minimal handling and data collection.

Disease or predation: Predation by invasive, epigeal (surface living) fish from farm ponds continue to present a threat to eggs, young-of-year, and juvenile Grotto Sculpin—the extent of which remains unknown. These fish may enter cave systems via sinkholes, when ponds are drained, or after flooding and high precipitation events. Predatory fish, including Green Sunfish (*Lepomis cyanellus*), Golden Shiner (*Notemigonus crysoleucas*), Largemouth Bass (*Micropterus salmoides*), Bluegill (*Lepomis macrochirus*), Longear Sunfish (*Lepomis megalotis*), and Yellow Bullhead (*Ameiurus natalis*) have been documented in caves occupied by Grotto Sculpin as recently as 2017, with high prevalence noted in Crevice Cave (Fenholtz et al. 2019). Investigations of acanthocephalan (phylum of thorny-headed worms) parasitism prevalence in Grotto Sculpin collected between February 2007 and October 2008 also revealed a potential threat to adult Grotto Sculpin. These findings showed a 75% parasite prevalence rate in caves and a 23% prevalence in non-cave adults. The majority of infections (52%) were restricted to the intestine, while some (5%) were found in the stomach and many (40%) showed infections across multiple gut tissues. The intensity of infections varied from 0 to 38 worms (*Leptorhynchoides thecatus*) per infected host with mean intensity and parasite abundance significantly higher in caves, particularly at Mystery Cave (Day et al. 2014).

Inadequacy of existing regulatory mechanisms: In spite of regulatory mechanisms, waterbodies with known Grotto Sculpin presence were listed in Missouri's 2020 303(d) List as impaired; however, this status provides eligibility for restoration under the state's Section 319 grant issued by the EPA through the CWA (DNR n.d.).

In the state of Missouri, the Grotto Sculpin is not state listed (MDC 2021). The species is afforded some protections under the Missouri State Endangered Species Law (MO ST 252.240), however, due to its federal status. Accordingly, the importation, transportation, sale, purchase, taking, or possession of endangered species, including the Grotto Sculpin, or their parts, and the sale or possession with intent to sell of any article made in whole or in part from endangered species is prohibited by the Wildlife Code of Missouri (3 CSR 10-4.111).

Because Grotto Sculpin are restricted to just five caves, they cannot readily escape local water quality degradation, as evidenced by two fish kills that occurred prior to the species' listing (USFWS 2013). Based on documented levels of contaminants present in caves and streams inhabited by Grotto Sculpin (Crites et al. 2019; USFWS 2013; Zheng et al 2013), and their inclusion in the state's 2020 303(d) List of impaired waterbodies (DNR n.d.), current regulatory mechanisms appear to be insufficient in preventing water degradation of Grotto Sculpin habitat, potentially putting the continued existence of the species at risk.

Other natural or manmade factors affecting its continued existence: In addition to restricted range, isolated populations and climate change (USFWS 2012; USFWS 2013), another manmade factor possibly affecting the continued existence of the Grotto Sculpin is nutrient deprivation resulting from the sealing and closure of open cave entrances. Allochthonous (outside surface

runoff) matter serves as an important source of organic matter input for cave systems. Sinkholes and natural cave openings in Perry County are routinely filled with trash, concreted, bulldozed, converted into ponds, obliterated by urbanization, or most commonly, converted to agricultural drains through the installation of standpipes in Perry County (Scott House, pers. comm. 2021). All of these manmade closures and obstructions reduce natural flows of organic matter into the Grotto Sculpin's habitat, thereby constricting the nutrient basis of food webs upon which the species depends.

Conservation Measures:

Local protections are afforded under the Perry County Community Conservation Plan (Plan) that addresses threats to Grotto Sculpin and provides benefits to water quality in the surrounding watershed. The Plan was developed in 2013 by local community members with support from State and Federal agencies, and is proactive, voluntary and self-regulatory. Included in the Plan are educational campaigns, threat prioritizations, and best management practice recommendations to address identified threats. Since the draft of the Plan, an additional management plan was developed by the community in 2019 to identify water quality impairments, including nonpoint source pollution concerns, and restoration opportunities to fulfill requirements for Section 319 funding (Crites et al. 2019).

Synthesis:

The Grotto Sculpin is a highly restricted species that continues to be known from only five cave systems in two karst areas in Perry County, Missouri. Though some additional protections have been afforded to the species since its listing in 2013, including protections under State law and local conservation plans, noncompliance and enforcement remain an issue. Full protection is also not afforded to habitat on private lands, especially sinkholes throughout the recharge area, which may lead to increased pollution exposure and siltation risk. This species exists in a fragile ecosystem and continues to face threats from water degradation and sedimentation, which may also be related to recent findings of high parasite prevalence and low preferred habitat availability. In addition, this species' restricted range and population isolation contributes to its vulnerability. Because of this and the continued presence of threats, the Grotto Sculpin still meets the definition of an endangered species.

Recommendations for future conservation actions:

- Work with and support partners in gaining an understanding of demographic features of Grotto Sculpin and ecological features of their habitat to aid in informing the development and implementation of a recovery plan. Researchers have indicated passive integrated transponder (PIT) tags may be safely applied to Banded Sculpin and therefore offer a feasible method of non-lethal monitoring to assess population characteristics of small fish species. Accordingly, PIT tag use in Grotto Sculpin could lead to insights into growth, recruitment, and mortality, as well as other characteristics essential for the conservation of the species (Fernholz and Phelps 2016). Research regarding the role of bats on the ecology of caves inhabited by Grotto Sculpin may also reveal ecological features vital to the species' recovery and delisting.

- Develop a draft and final recovery plan for the Grotto Sculpin. The recovery plan should include objective, measurable delisting criteria. Recovery criteria should address all known threats meaningfully impacting the species, and should estimate the time required as well as the cost to carry out those measures needed to achieve the goal for recovery and delisting.
- Collaborate with MDC and other partners on the identification and implementation of priority land acquisitions, easements and/or cave entrance protection measures, as well as population monitoring, point and non-point pollution source inventories and vulnerability mapping of known recharge zones with viable Grotto Sculpin populations.
- Support the engagement of Federal, State, local, tribal, and private partners in Grotto Sculpin recovery.

RESULTS

**U.S. FISH AND WILDLIFE SERVICE
STATUS REVIEW of *Cottus specus***

Current Classification: Endangered

Status Recommendation resulting from Status Review:

- Downlist to Threatened
- Uplist to Endangered
- Delist (Indicate reasons for delisting per 50 CFR 424.11):
 - The species is extinct
 - The species does not meet the definition of an endangered or threatened species.
 - The listed entity does not meet the statutory definition of a species.
 - No change needed

REGIONAL OFFICE APPROVAL:

Lead Assistant Regional Director (ES), Fish and Wildlife Service

Approve _____ Date _____

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¹ Julie Day, researcher and former aquatic biologist with the National Park Service, peer-reviewer

² Joseph Gerken, researcher and instructor with Kansas State University, peer-reviewer, provided information

³ Jason Crites, fisheries management biologist with the Missouri Department of Conservation, peer-reviewer

⁴ Dave Herzog, science unit supervisor with the Missouri Department of Conservation, peer-reviewer

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Table 1. Density of Grotto Sculpin found by Adams et al. (2008) between 2005 and 2008 and Fernholz (2019) between 2015 and 2017 in cave and surface streams aka resurgence areas (Fernholz et al. 2019).

Cave	Adams Density (fish/m ²)	Fernholz Density (fish/m ²)
Thunderhole Resurgence	1.02 ± 0.093	0.38 ± 0.359
Running Bull	0.14 ± 0.024	0.03 ± 0.006
Mystery Cave	0.06 ± 0.009	0.06 ± 0.003
Mystery Resurgence	0.03 ± 0.006	0.13 ± 0.016
Tom Moore Cave	----	0.04 ± 0.002
Blue Springs Resurgence	----	0.40 ± 0.046

Table 2. Habitat type and availability in three caves inhabited by Grotto Sculpin between 2015 and 2017 (Fernholz et al. 2019, summarized by Ashley Riedel/USFWS).

Cave Name	Macrohabitat Type			Substrate Type			Depth	Velocity	Total
	Type	M ²	%	Type	M ²	%	% (0.10-0.19m)	% (0.00-0.09m/s)	M ²
Running Bull	Run	255	41.80	Bedrock	123	20.16	37.54	49.67	610
	Riffle	212	34.75	Boulder	59	9.67			
	Pool	143	23.44	Cobble	60	9.84			
				Gravel	109	17.87			
				Sand	85	13.93			
				Mud	174	28.52			
Tom Moore	Run	2,365	67.42	Bedrock	2,534	72.23	88.74	43.19	3,508
	Riffle	876	24.97	Boulder	407	11.6			
	Pool	267	7.61	Cobble	466	13.28			
				Gravel	26	0.74			
				Sand	13	0.37			
				Mud	62	1.77			
Mystery	Run	1,894	57.57	Bedrock	1,738	52.83	48.21	36.96	3,290
	Riffle	1,317	40.03	Boulder	450	13.68			
	Pool	79	2.40	Cobble	59	1.79			
				Gravel	662	20.12			
				Sand	27	0.82			
				Mud	354	10.76			

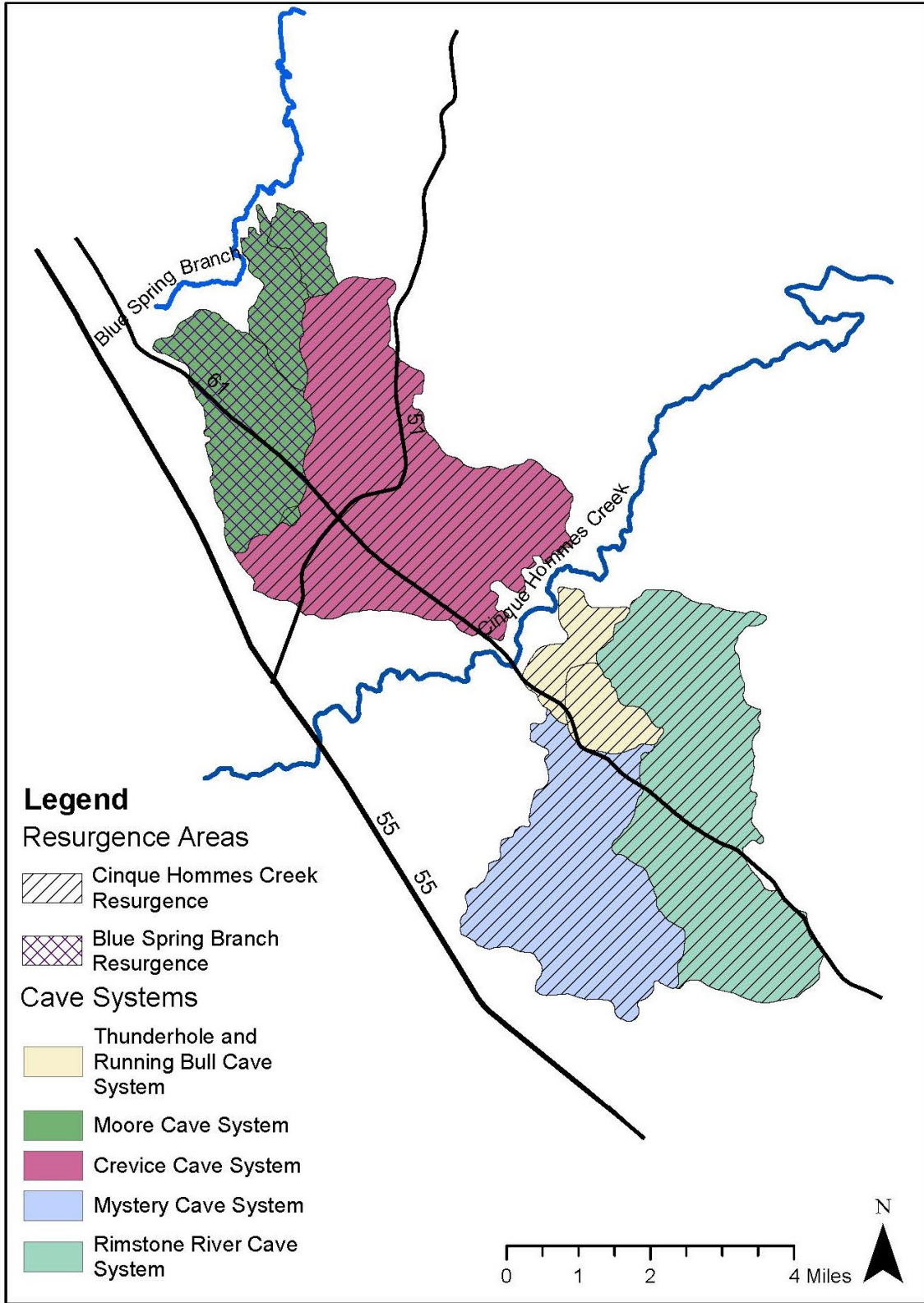


Figure 1. Map of resurgence areas and their associated cave systems representing overall Grotto Sculpin habitat range (Katie Kelly/USFWS 2020).



Figure 2. Photo of a captured male and female Grotto Sculpin from potential nest site (A), a gravid female (B), and a milting male (C) in October, 2016 (Fernholz et al. 2019).

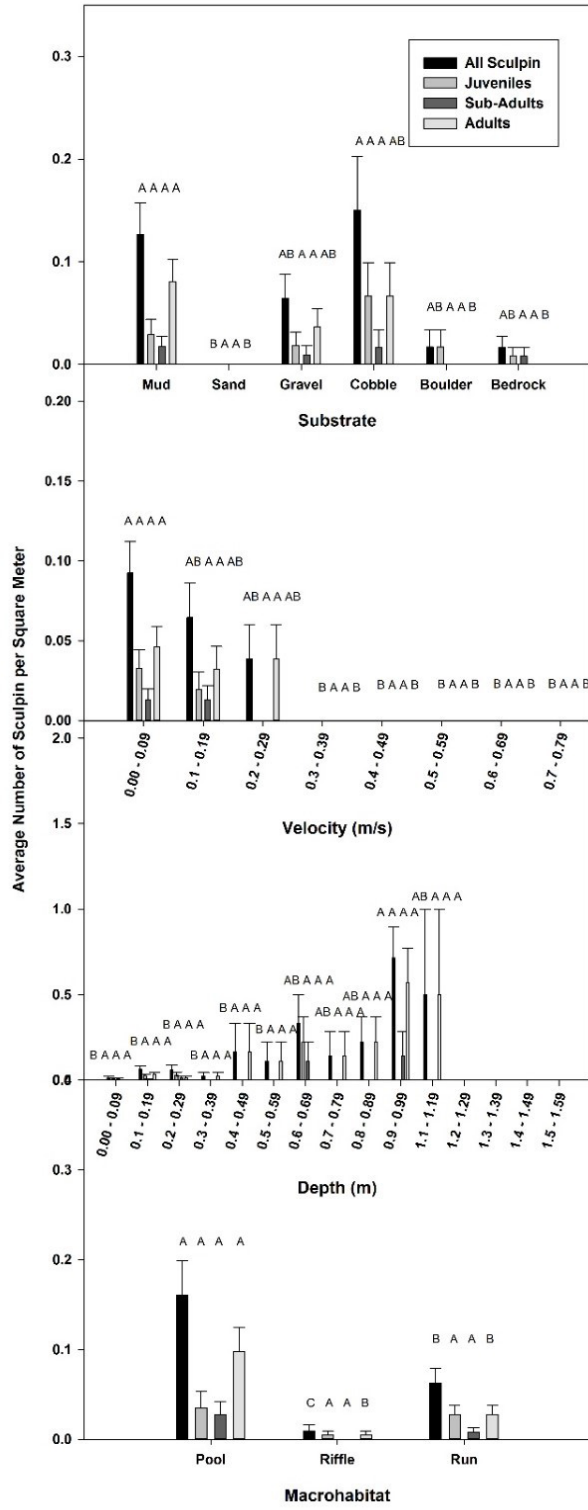


Figure 3. Grotto Sculpin abundance with standard error bars by substrate, velocity, depth and macrohabitat type for all age categories (i.e., juveniles, sub-adults, adults, and all sculpin) showing habitat selectivity within Running Bull Cave between 2015 and 2017 (Fernholz et al. 2019).

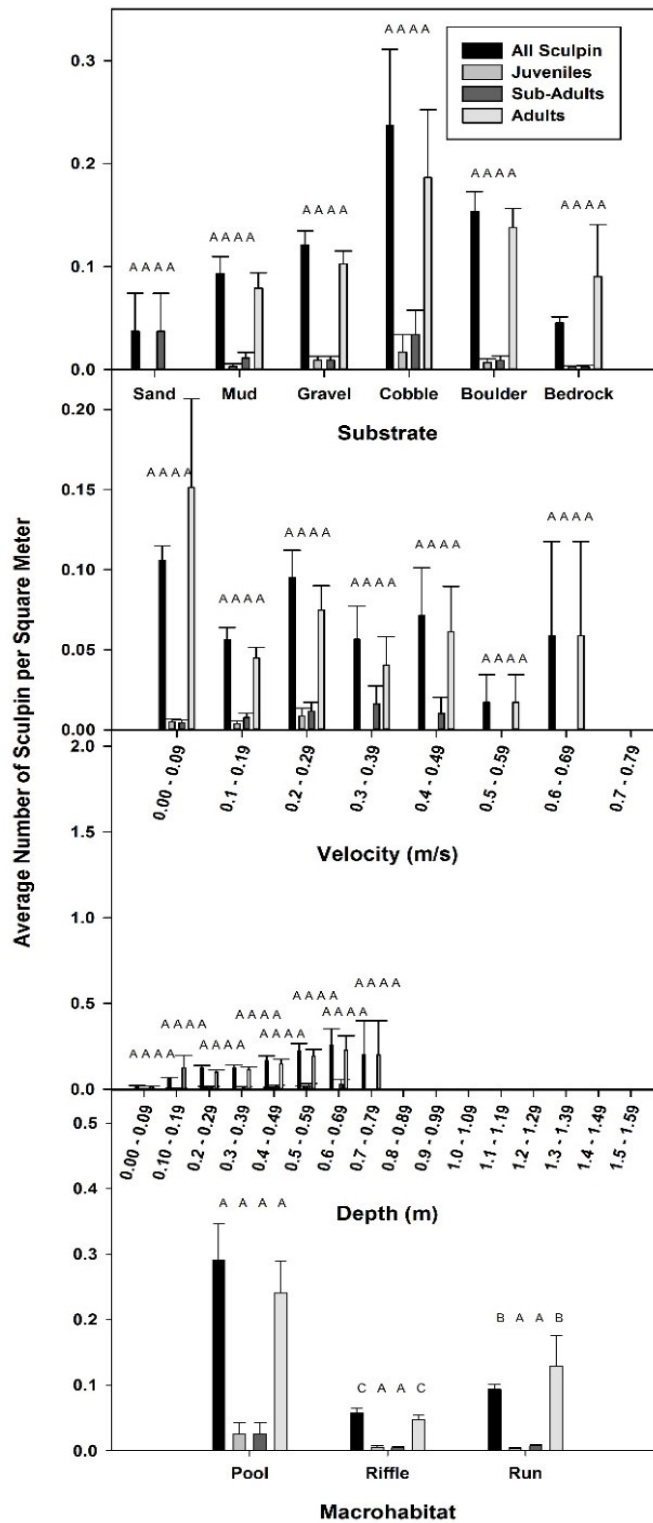


Figure 4. Grotto Sculpin abundance with standard error bars by substrate, velocity, depth and macrohabitat type for all age categories (i.e., juveniles, sub-adults, adults, and all sculpin) showing habitat selectivity within Mystery Cave between 2015 and 2017 (Fernholz et al. 2019).

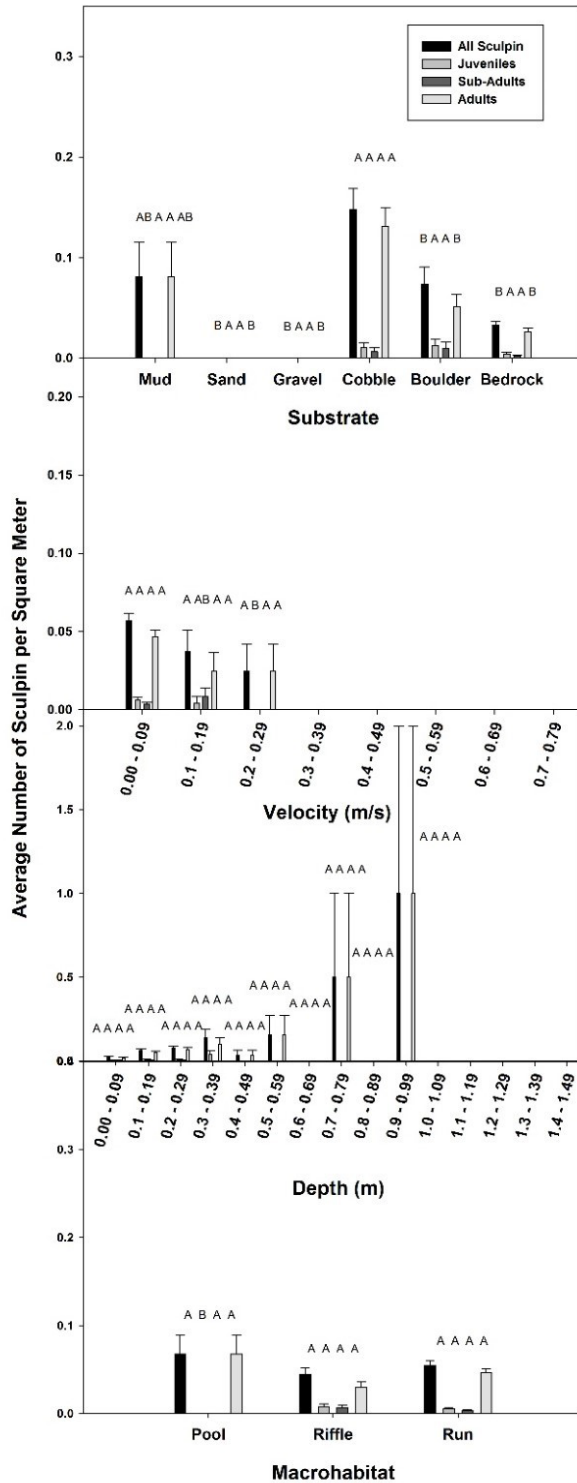


Figure 5. Grotto Sculpin abundance with standard error bars by substrate, velocity, depth and macrohabitat type for all age categories (i.e., juveniles, sub-adults, adults, and all sculpin) showing habitat selectivity within Tom Moore Cave between 2015 and 2017 (Fernholz et al. 2019).

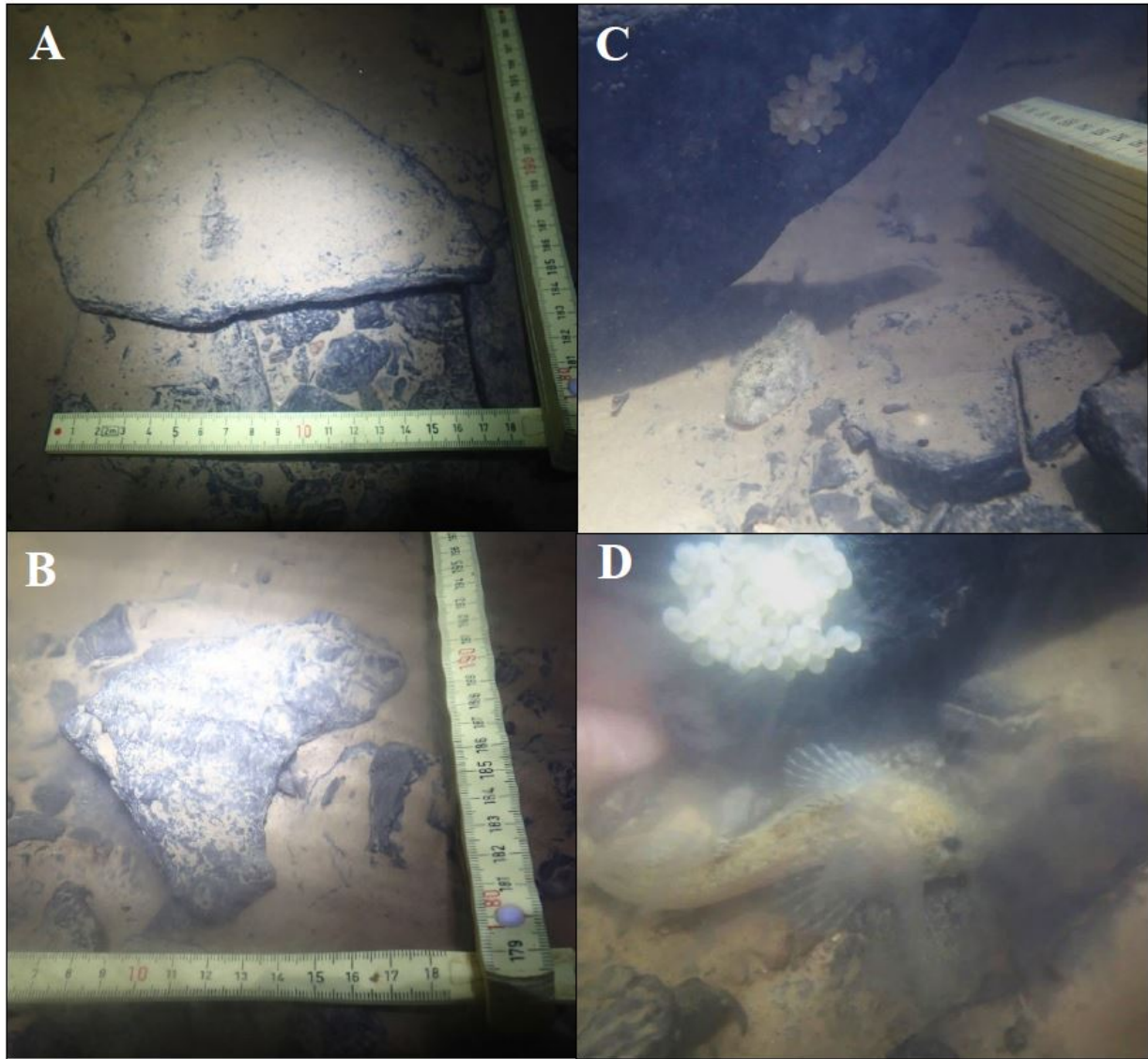


Figure 6. Visually identified Grotto Sculpin nest sites (A, B) with eggs and males exhibiting sweeping and guarding behavior (C, D) under rocks (Fernholz et al. 2019).