

BULKHEAD COVE SODIUM SULFITE TREATMENT MONITORING

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BACKGROUND

Chemical nonnative fish removal tools are limited with only rotenone being commercially produced, but in recent years a search to find new tools has begun (Ward 2005; Ward et al. 2013). One promising tool currently being researched is sodium sulfite. It works by scavenging oxygen and is recognized as safe by the US EPA and is commonly used as a food preservative. For fish removal treatments a powder form of sodium sulfite is applied to the water, the sodium ion is removed, and the sulfite binds with oxygen to become the more stable sulfate. This causes oxygen depletion in the water column and results in many fish surfacing to gulp air. This allows fish to be successfully salvaged and removed from a water body they were not desired to be in. Fish not removed from the deoxygenated water will die.

Bulkhead Cove is an approximately 0.8-hectare body of water that has been isolated from Lake Havasu by a semipermeable berm. Bulkhead Cove has a population Green Sunfish *Lepomis cyanellus*, Yellow Bullhead *Ameiurus natalis*, and Red Swamp Crayfish *Procambarus clarkia*. Previously Bonytail *Gila elegans* had been stocked into Bulkhead but have not been detected after stocking. If nonnative fish were removed from Bulkhead it would have value as a off-channel backwater for native fish grow out or refuge populations.

Due to its small size, nonnative assemblage, and potential for conservation of federally listed Bonytail and Razorback Sucker *Xyrauchen texanus*, Bulkhead Cove was selected as a candidate for an experimental sodium sulfite treatment. The following paper will discuss our efforts to:

- A. Establish initial size structure and population estimates for nonnative fishes in Bulkhead Cove prior to treatment with sodium sulfite.
- B. Assess for potential reduction in population size and modification of size structure following sodium sulfite treatment.
- C. Evaluate overall effectiveness of sodium sulfite as a fish removal tool in Bulkhead Cove and examine for future application.

METHODOLOGY

MAY SAMPLING

On the afternoon of May 25, eight hoop nets were deployed in Bulkhead Cove overnight. The nets were pulled and processed the morning of May 26. A subsample of fish from May hoop netting were measured for total length (TL) in millimeters (mm). A clip of the caudal fin was

taken from all specimens captured during the May assessment for mark-recapture population estimates, with the recapture event occurring during the treatment.

OCTOBER SAMPLING

Eight hoop nets were deployed in Bulkhead Cove the afternoon of October 3 and left overnight. Nets were pulled and processed on October 4. All fish collected during October hoop netting were measured for total length (TL) in millimeters (mm). No population estimates were obtained during October sampling.

SODIUM SULFITE TREATMENT

Sodium sulfite was applied at a rate of approximately 0.6 grams per gallon of water (i.e., 17 bags, 22.7 kg of sodium sulfite per bag to 634,000 gallons of water) was applied to Bulkhead Cove on June 6, 2023. Surfacing fish were dip netted from watercraft, removed from Bulkhead Cove, assessed for a fin clip, and translocated to Lake Havasu. A follow-up dip netting trip occurred on June 7, 2023, to recover dead fish from the initial day of treatment and gather more mark-recapture data for population estimates.

A HydroLab multiparameter sonde was utilized to determine the amount of time required to diminish dissolved oxygen (mg/L) during treatment. Dissolved oxygen was monitored at the deepest point in Bulkhead Cove after application of sodium sulfite.

POPULATION ESTIMATE

Population estimates were calculated using the modified Lincoln-Peterson formula (i.e.,

$$N = \frac{(M+1)(C+1)}{(R+1)} \text{ (Lockwood and Schneider 2000).}$$

M (marked individuals) were the number of fish captured on May 26, C (captured individuals) were the total number of fish captured between June 6 and 7, and R (recaptures) were the number of recaptures between M and C determined with the presence of caudal fin clips.

The 95% confidence intervals were calculated by obtaining low and high values of R (recaptures) using a Poisson distribution table or the equation $R + 1.92 \pm 1.96\sqrt{R + 1.0}$ based on the number of recaptures (Ricker 1975; Lockwood and Schneider 2000). The new R values were substituted into the modified Lincoln-Peterson formula to obtain upper and lower confidence limits.

RESULTS

POPULATION ESTIMATE

For Green Sunfish, there were a total of 751 marks (M) from initial hoop netting, 2,245 captures (C) following sodium sulfite treatment, and 159 recaptures (R) with an estimate population (95% confidence interval) of 10,556 (9,046-12,318) individuals.

For Yellow Bullhead, there were a total of 6 marks (M) from initial hoop netting, 73 captures (C) following sodium sulfite treatment, and 2 recaptures (R) with an estimate population (95% confidence interval) of 173 (63-432) individuals.

During the sodium sulfite treatment dissolved oxygen at the deepest point in Bulkhead Cove decreased from 3.6 mg/L to 0.0 mg/L within 37 minutes of application.

Captures via hoop netting and corresponding catch per unit of effort (CPUE) of Green Sunfish *Lepomis cyanellus* and Yellow Bullhead *Ameiurus natalis* decreased following treatment of sodium sulfite in Bulkhead Cove (Table 1). Red Swamp Crayfish *Procambarus clarkii* captures post-treatment (N = 6) were greater than pre-treatment captures (N = 0).

Table 1. Hoop netting captures and catch per unit of effort (CPUE) for Green Sunfish, Yellow Bullhead, and Red Swamp Crayfish in Bulkhead Cove pre- and post-sodium sulfite treatment.

	Pre-Treatment		Post-Treatment	
	N	CPUE	N	CPUE
Green Sunfish	751	93.9	201	25.1
Yellow Bullhead	6	0.8	1	0.1
Red Swamp Crayfish	-	-	6	0.8

Dip netting following sodium sulfite treatment resulted in the collection of 2,245 Green Sunfish, 73 Yellow Bullhead, and 43 Red Swamp Crayfish (Table 2).

Table 2. Captures of Green Sunfish, Yellow Bullhead, and Red Swamp Crayfish from dip netting at Bulkhead Cove following sodium sulfite treatment.

	Green Sunfish		Yellow Bullhead		Red Swamp Crayfish
	Captures	Recaptures	Captures	Recaptures	
6-Jun-23	1,862	123	64	1	42
7-Jun-23	383	36	9	1	1
Total	2,245	159	73	2	43

Prior to sodium sulfite treatment, 60-to-90 mm Green Sunfish constituted 62.5% of sampled specimens (Figure 1). This increased to 93.5% after Bulkhead Cove was treated. Specimens over 100 mm represented 12.5% of captured individuals prior to treatment and decreased to 1.0% after application.

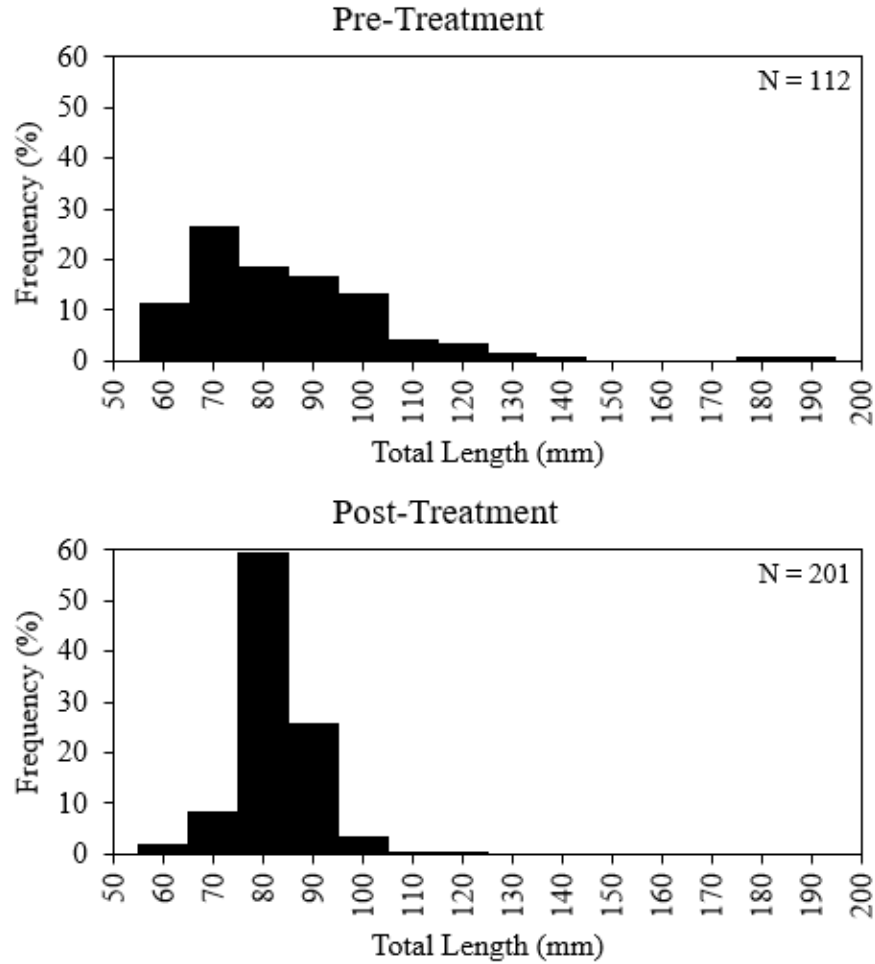


Figure 1. Length-frequency distributions for measured Green Sunfish obtained via hoop netting in Bulkhead Cove pre- and post-sodium sulfite treatment.

DISCUSSION

The depletion of dissolved oxygen in Bulkhead Cove following the application of sodium sulfite and concurrent removal of individuals via dip netting and death of non-salvaged fish caused a substantial decrease in hoop netting catch rates of Green Sunfish and Yellow Bullhead. Despite a lack of complete success, sodium sulfite was effective as a fish removal tool in this experiment.

The lack of a complete removal of fish from Bulkhead Cove is likely tied to two factors. The first being the semipermeable berm between Bulkhead and Lake Havasu. Lake Havasu water levels were rising during the treatment; it is likely that inflow of oxygenated water from Lake Havasu to Bulkhead Cove may have aided in the survival. Another factor was Bulkhead Cove contained large amounts of algae during the treatment. Small Green Sunfish were visually observed during and after the treatment near shore amongst algae and aquatic vegetation, perhaps taking advantage of a dissolved oxygen refuge. The treatment may have yielded a higher removal rate of fish in a scenario where Bulkhead Cove had a higher water level than Lake Havasu, thus removing any potential dissolved oxygen inflow or in a time of year where less algae and aquatic vegetation was present.

In addition to reducing the number of Green Sunfish present, the sodium sulfite treatment caused a shift in the size structure in Bulkhead Cove. Examination from pre- and post-treatment reveals a general reduction in Green Sunfish greater than 100 mm. The shift of a higher proportion of 70-to-80 mm Green Sunfish from 60-to-70 mm fish suggests this 60-to-70 mm cohort best survived treatment and correspondingly exhibited growth. These fish appear to have been more successful in finding oxygen refuges.

Red Swamp Crayfish were still found in Bulkhead Cove after the treatment. However, the removal and translocation of 43 of these specimens immediately following application displays the validity of this products' potential for crayfish removal.

FUTURE WORK

Bulkhead Cove should receive future treatments of sodium sulfite to further evaluate its effectiveness under optimal circumstances. Conditions where greater success of nonnative fish removal could occur include a lowered density of algae and aquatic vegetation, and an artificial raising of Bulkhead Cove's water level such that it is higher than that of Lake Havasu.

LITERATURE CITED

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