CITIZEN PETITION FORM

Submitted March 4, 2025

Date:	January 29, 2025

Issue:	Proposed regulation to address risks of baitfish importation in Colorado

Which rule are you seeking to create or revise? Please include a copy of the rule you are proposing to create or change, preferably with the change made in redline format.

We propose a modification to CCR 406 Chapter W-0. The full rule with proposed changes highlighted is attached as Addendum 1.

Why are you seeking to create or revise this rule? Please include a general statement of the reasons for the requested rule or revision and any relevant information related to the request.

Please see the attached document entitled "Proposed regulation to address risks of baitfish importation in Colorado" for a full explanation.

Petitioner's name:	Amanda Hansen

Colorado Parks and Wildlife Commission
c/o Hilary Hernandez, Regulations Manager
6060 Broadway
Denver, CO 80216

Subject: A Call to Safeguard Native Fish and Biodiversity by Prohibiting Live Baitfish Imports

Dear Colorado Parks and Wildlife Commissioners,

As a coalition of conservation and angling organizations, we share your commitment to protecting Colorado's natural heritage and support focused action to prohibit the importation of live baitfish. This practice poses significant risks, including the introduction of invasive species and harmful pathogens that threaten the health of native fish populations and aquatic ecosystems.

The ecological impacts of live baitfish imports are well-documented. Invasive species can outcompete native plants and animals, causing disruptions to Colorado's fragile aquatic ecosystems. **In addition, live baitfish imported from other regions introduce unique risks, as they may carry pathogens and invasive species not naturally found in Colorado but capable of thriving in its waters.** This cross-regional transmission amplifies threats to the state's ecosystems. These risks not only jeopardize Colorado's biodiversity but also impose economic burdens, as managing invasive species and restoring damaged ecosystems are costly endeavors.

Several states, including Maine, Minnesota, and Montana, have successfully addressed these threats by restricting or banning live baitfish imports. These policies have reduced the spread of invasive species and supported healthier fisheries. **Colorado now has the opportunity to follow their lead and become a model for effective environmental management.**

We respectfully call on Colorado Parks and Wildlife to enact a prohibition on live baitfish imports to preserve native biodiversity and ensure that fishing remains a valued tradition for future generations.

We stand ready to support this effort and provide any additional information or assistance needed to advance this important regulatory initiative.

Sincerely,

The Undersigned Organizations

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UPSTREAM AQUATIC INSTITUTE

Proposed regulation to address risks of baitfish importation in Colorado

January 2025

Victoria DeRooy & Amanda Hansen

Executive summary

This report proposes a modification to Colorado's regulations regarding the importation and sale of live baitfish for use as bait.

In many areas of Colorado, current regulations permit the importation and sale of cultured (aquaculture-produced) baitfish from outside the state. The non-local culture and importation of live baitfish poses a significant risk of introducing invasive species and pathogens into Colorado's aquatic ecosystems. Studies of live baitfish sold across the U.S. routinely document the presence of aquatic invasive species and/or aquatic pathogens and parasites. Using these fish as live bait therefore carries the risk that such aquatic invasive species, pathogens, and parasites will become established in Colorado's lakes and rivers. A number of aquatic invasive species have become established in Colorado via this pathway already. Experience from other states has shown that angler outreach is largely ineffective.

These invasive species and diseases pose a significant risk to both economic and non-economic aquatic activities in Colorado. When invasive species become established in Colorado's waterways, the state must pay for costly, ongoing management programs, while also suffering losses in the amenity value of Colorado's lakes and rivers.

We propose a regulatory change to mitigate the current risks associated with the introduction of invasive aquatic species and pathogens into Colorado's waterways. We propose two options:

1. A prohibition on the use of all cultured baitfish in Colorado. This prohibition would continue to permit, where currently allowed, anglers catching and using their own baitfish on the same body of water.

2. Alternatively, a prohibition of the import of baitfish into Colorado from out-of-state producers.

The only difference between these two options is that the latter option would enable aquaculture producers in Colorado to adopt baitfish production in the future, should any businesses choose to do so. Currently, there are no aquaculture operations in Colorado producing fish for sale and use as live bait.

Baitfish sold in Colorado originate from out-of-state sources, with no domestic commercial production. The economic impact of a ban on live baitfish importation for Colorado stakeholders should be minimal, as bait and tackle shops derive the majority of their revenue from other products and services. Public opinion on the proposed regulation is generally supportive or neutral, with a majority of anglers indicating they would not significantly alter their fishing habits. This is corroborated by a formal statistical analysis, which demonstrates that similar baitfish restrictions in other U.S. states have not affected public participation in angling.

Overall, the prohibition of importation of live baitfish into Colorado, is a realistic and proportional solution. Compared to the status quo, a prohibition on importation would effectively address the risk posed to Colorado's aquatic ecosystems and provide anglers with regulatory clarity.

1. Proposed modification to regulation

We propose a modification to CCR 406 Chapter W-0. The full rule with proposed changes highlighted is attached as Addendum 1.

Into Chapter W-0, Article VII, #011 (Importation of Aquatic Wildlife), insert:

> It shall be unlawful for any person to import any aquatic wildlife for sale or use as bait; or to sell any imported aquatic wildlife for use as bait; or to purchase any imported aquatic wildlife for use as bait.

Into Chapter W-0, Article I, #000 (Definitions), insert a definition of bait (the following definition is from Chapter W-1):

> "Bait" means any hand-moldable material designed to attract fish by the sense of taste or smell; those devices to which scents or smell attractants have been added or externally applied (regardless if the scent is added in the manufacturing process or applied afterward); scented manufactured fish eggs and traditional organic baits, including but not limited to worms, grubs, crickets, leeches, dough baits or stink baits, insects, crayfish, human food, fish, fish parts or fish eggs.

2. Current regulations on baitfish in Colorado

Colorado has some regulations on the use of live baitfish in the state. However, these regulations have several key limitations that hinder their effectiveness in mitigating the risk posed by the transport and use of live baitfish.

The importation of fish into Colorado is governed by CCR 406 Chapter W-0 Article VII. In order to import and sell baitfish from out of state, a bait dealer must obtain an importation license at least 7 working days prior to importation. Under #014 (A. 1.) and #011 (F), out-of-state aquaculture facilities producing fish for importation into Colorado must be inspected annually, and the resulting health certification must accompany shipments of live fish into Colorado.

However, the details of these health inspections render their effectiveness limited when it comes to mitigating the risk of aquatic invasive species. For non-salmonids, health inspections must check for Viral Hemorrhagic Septicemia Virus (VHSV) as well as other diseases such as Spring Viremia of Carp Virus (SVCV) when applicable. These inspections therefore only account for a handful of diseases and make no reference to the presence of non-target fish species or other invasive aquatic species. Scientific analyses of live baitfish across the U.S. routinely detect a variety of pathogens and numerous non-target invasive aquatic species (see section 3.3 below and Table 2 below in this report), which demonstrates limitations in the health certificates required under Colorado regulations.

Additionally, these health certificates are not collected by the state but are required to remain with the shipments and be presented to officials if requested. However, the State of Colorado's Aquatic Nuisance Species Management Plan report specifically notes a lack of enforcement capacity to visit bait shops, which means there is currently no systematic checking of these health certificates.

The sale of baitfish by dealers is governed by CCR 1201 Chapter 21 Part 2, which states that bait dealers must register as an aquaculture facility but are exempt from the fee and most requirements otherwise imposed on aquaculture facilities. Exceptions are a requirement to maintain certain records and provide customers with a receipt detailing the seller's name, address, the date of sale, the species, and the number sold. On the publicly available list of aquaculture permittees, it is clear that only a handful of bait dealers have complied with this and registered. Based on our own observations, many stores also did not issue receipts for the purchase of baitfish that complied with all the requirements.

The use of baitfish by anglers specifically is governed by CCR 406 Chapter W-1 Article 1 #104. The use of live baitfish is restricted in some areas of Colorado, while other

areas of the state have minimal restrictions. The specific allowances for the collection, transportation, and use of baitfish are summarized in the following table (Table 1) and map (Fig. 1).

Beyond being somewhat cumbersome for anglers to understand and follow, these regulations allow for baitfish produced out-of-state to be imported into Colorado and then used in many of Colorado's lakes and rivers. The area where out-of-state baitfish can be purchased and used covers a large area of Colorado's waterways (see smaller map in Fig. 1). The growing number of introduced aquatic species in Colorado, including many from bait bucket introductions, raises questions about the effectiveness of this set of regulations on anglers' use of baitfish (see sections 3.2 and 3.3 below).

Table 1. Current regulations on live baitfish use in Colorado (CCR 406 Chapter W-1 Article 1 #104 H).

Area in Colorado	Baitfish regulations
East of the continental divide and below 7000 ft elevation • Excluding the Arkansas River above Parkdale-Fremont and Chaffee counties • Excluding Watson Lake - Larimer County Navajo Reservoir	Live baitfish legally purchased can be used anywhere. An angler must have the receipt with them. Anglers can harvest baitfish for personal use and use them in the same body of water where they were collected. Collection and use is also allowed from man-made ditches and canals, and these baitfish can be used in the adjoining lake or reservoir. Personally collected baitfish cannot be transported or stored for later use.
West of the continental divide or above 7000 ft elevation • Excluding Navajo Reservoir The Arkansas River above Parkdale – Fremont and Chaffee counties Watson Lake - Larimer County	Live baitfish use is prohibited.
Baca, Bent, Crowley, Kiowa, Otero and Prowers Counties	Anglers can collect baitfish for personal use and transport, store, or use them anywhere within the listed counties. These baitfish cannot be transported to or used in any other counties.

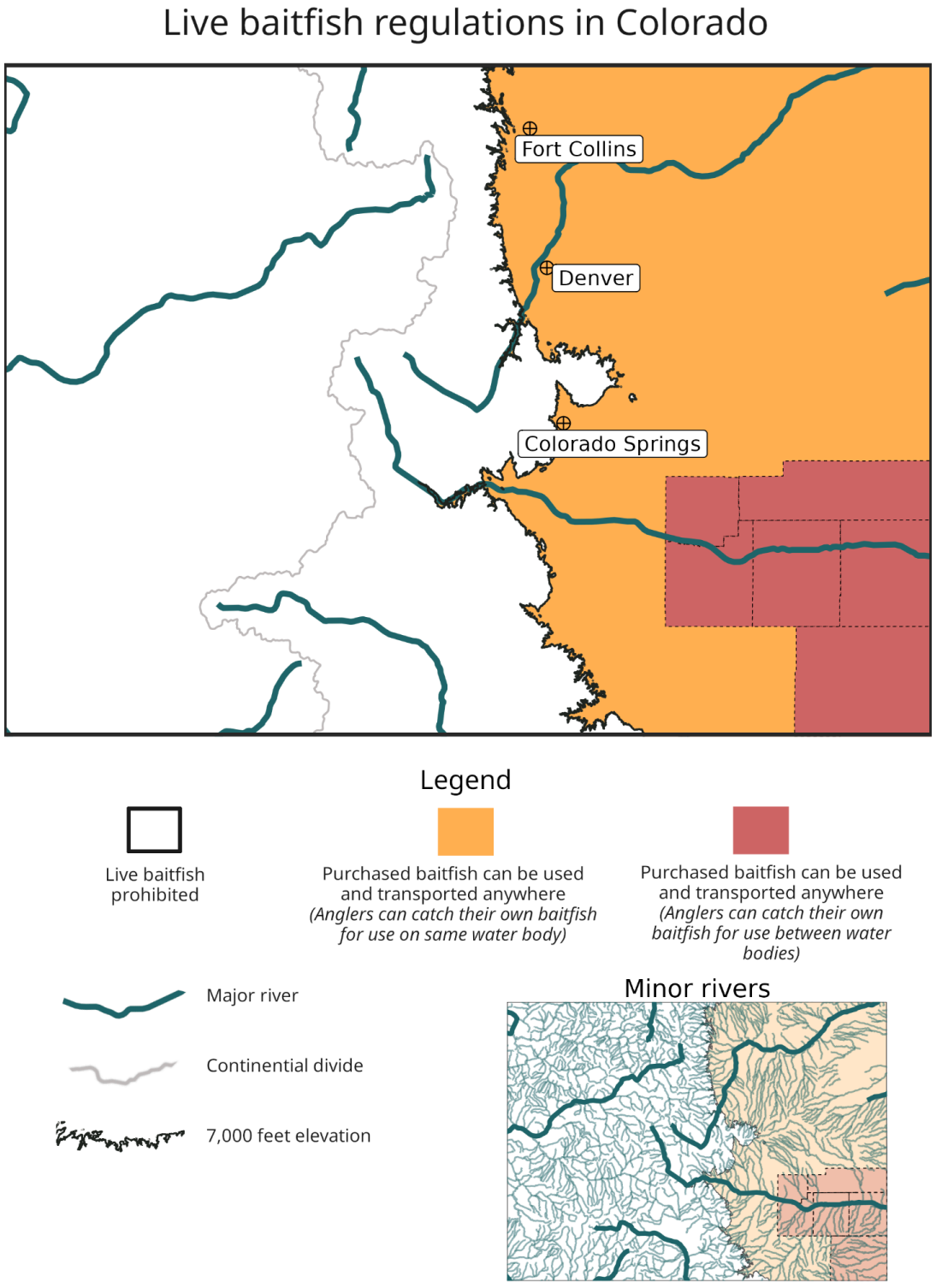


Fig. 1. Map illustrating current regulations on live baitfish use in Colorado.
Map credit: The authors, based on Colorado regulations.

3. Risks caused by the import of live baitfish into Colorado

3.1. The source of Colorado's live baitfish supply

It appears that most or all baitfish sold by shops in Colorado originate from outside the state (specifically Arkansas, Kansas, Missouri, Nebraska, and possibly Minnesota). It is unclear whether baitfish imported into Colorado originate from wild-harvested sources or from aquaculture operations in those states.

Importation from outside of Colorado by wholesalers/distributors

Communications with Colorado Parks and Wildlife (CPW) revealed that in 2022 there were nine licensed bait dealers in Colorado that worked with out-of-state facilities holding importation permits and fish health certificates.

Under the Colorado Open Records Act, we obtained data on licenses granted for the importation of fish into Colorado. This data shows that, in 2023, fathead minnows were imported into Colorado from Arkansas, Kansas, Missouri, and Nebraska. However, it is challenging to specify the number of permits or certificates issued solely for baitfish, as these permits also cover fish intended for stocking as feeder fish for sportfish. It is also impossible to distinguish between wild-harvested and cultured baitfish in these records. Nevertheless, this data is partially corroborated by a 2019 report, which stated that baitfish in Colorado were primarily supplied from Arkansas and Minnesota (*1*).

Domestic wild harvest

We can have confidence that the commercial wild harvest of baitfish is not an economic activity in Colorado. While regulations allow wild harvest for commercial purposes with a permit, CPW has confirmed that no such permits have been issued. Consequently, wild harvest of baitfish in Colorado is exclusively for personal use, and it is unlikely that domestic wild harvest represents a source of baitfish sold in bait shops.

Domestic aquaculture

The second regulatory option we propose in this report—a prohibition on the importation of live baitfish from other states—may represent an opportunity for Colorado's domestic aquaculture.

Currently, there are no farms in Colorado producing fish specifically for use as live bait. Outreach to all aquaculture facilities in the state revealed no farms engaged in baitfish production, suggesting that the farm reported in the 2023 USDA census of

aquaculture as selling fathead minnows (down from two farms in 2018) is likely producing minnows for stocking or research purposes rather than for bait.

If our second proposed regulatory option (an importation ban) is adopted, then the domestic production and sale of baitfish within Colorado would be permitted. This may represent an opportunity for businesses in Colorado to expand to meet this demand.

3.2. Aquatic invasive species in Colorado

Invasive species and diseases significantly impact the U.S. economy (*2*). The most rigorous and up-to-date source that provides information on the financial costs of aquatic invasive species is the InvaCost database, which stores data on the costs of dealing with invasive species that have been published in scientific journals. Of aquatic invasive species whose economic costs have been estimated, the average cost incurred due to an aquatic invasion in the United States is $7.4 million (*3*).

The Colorado Aquatic Nuisance Species Management Plan adopts a proactive approach to this issue, emphasizing prevention and early detection as the cornerstones of cost-effective invasive species management (*4*). This aligns with the National Park Service's findings, which indicate that the expenses related to prevention strategies are markedly lower than the long-term costs of control and management once invasive species have become established (*5*).

Indeed, the number of introduced species in Colorado's lakes and rivers has steadily grown over time, highlighting a concerning trend and supporting the need for further management (Fig. 2).

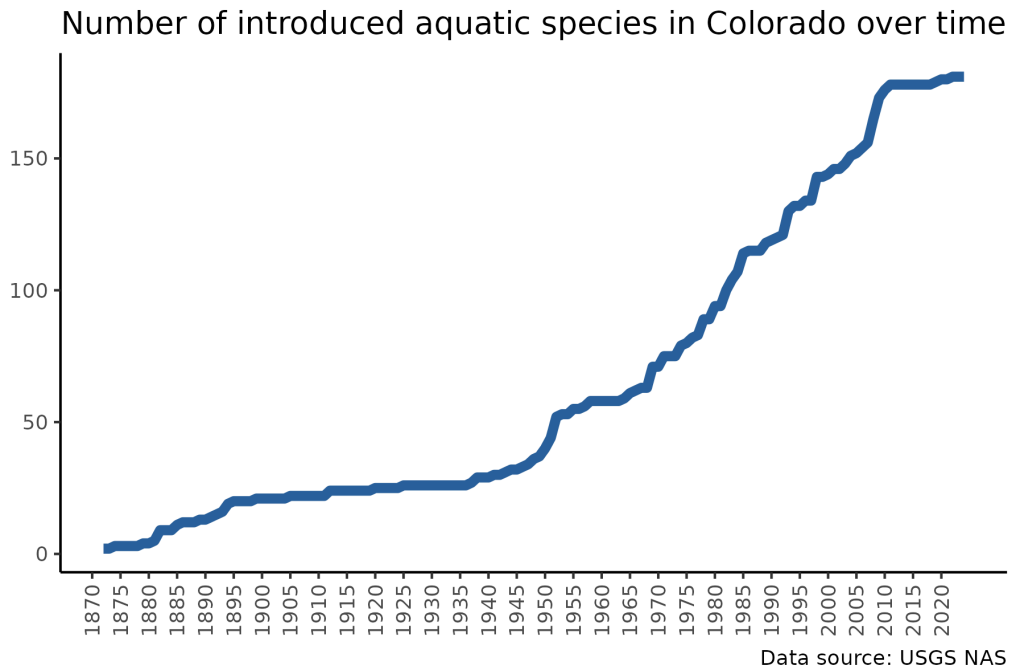
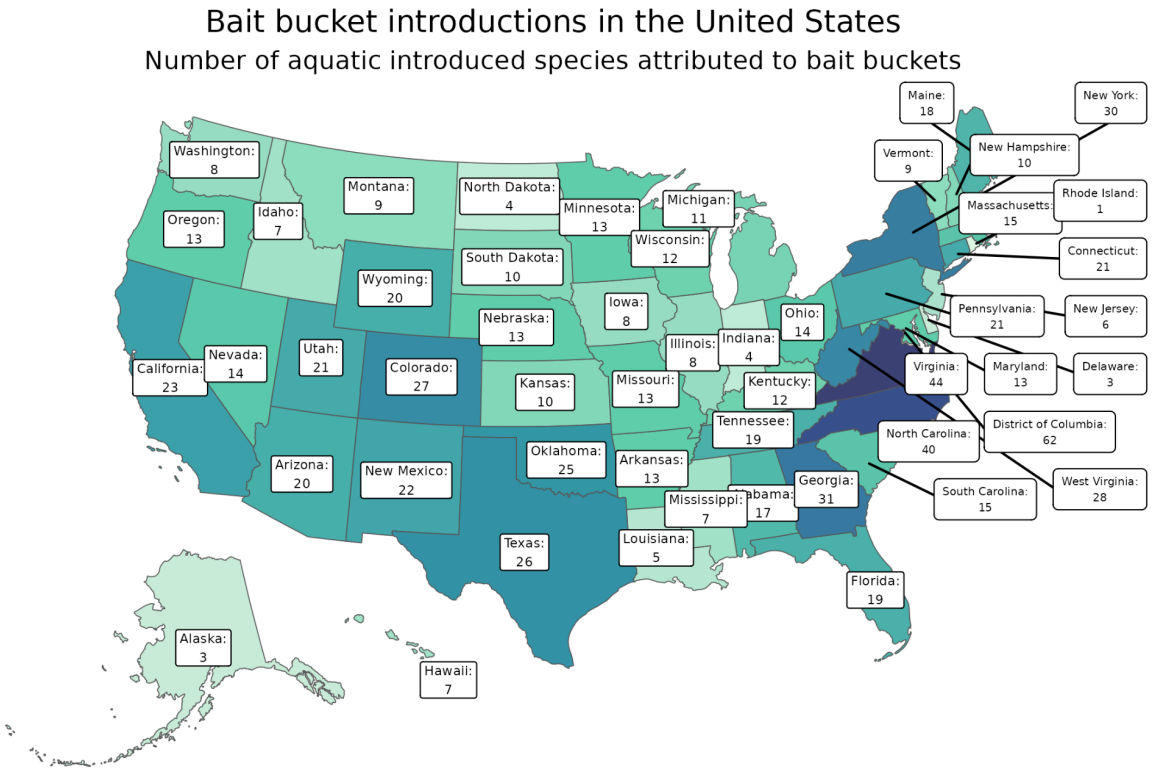


Fig. 2. The trend of introduced aquatic species in Colorado over time. *Data: USGS NAS.*

3.3. Trends in invasive species caused by the baitfish trade

According to the database maintained by the United States Geological Survey, the bait trade has caused the introduction of aquatic invasive species in every U.S. state (Fig. 3). So far, in Colorado, 27 aquatic species have been introduced by the bait trade. This data does not include introduced aquatic species of unknown origin.



Data source: USGS NAS

Fig. 3. Bait bucket introductions by state.
Data: USGS NAS.

Multiple scientific publications have reported on the presence of invasive aquatic species, unadvertised or illegal species, parasites, and/or viral and bacterial pathogens in the baitfish trade. The following table summarises, to the best of our knowledge, every published study that reports original data on these organisms in the baitfish trade in the U.S.

Every study documented the presence of problematic species, frequently including highly invasive species or highly destructive pathogens, in the sampled baitfish.

Studies varied in purpose, methodology, date, and region, resulting in differences in the specific organisms identified. Notably, every study documented the presence of invasive species or pathogens, highlighting that the baitfish supply chain across states is consistently associated with these risks. While some states are not represented in the table, this reflects a lack of published research rather than an absence of problematic species. Importantly, the studies in this table include research from several states known to supply baitfish to Colorado.

Beyond the original data reported in the below studies, other studies have attributed a variety of invasive aquatic species in the United States and Canada to the baitfish trade (*6*–*12*).

Table 2. Literature review of publications testing for the presence of invasive aquatic species, non-advertised aquatic species, and pathogens in the United States

Source	Date and study region	Study method	Species detected	Notes
Mulligan et al. 2023 (*13*)	2022 (ND, SD, IA, NE, KS)	eDNA and qPCR to detect invasive and/or unadvertised fish species	Invasive species: silver carp *(Hypophthalmichthys molitrix*) bighead carp (*H. nobilis*) Unadvertised species: black bullhead (*Ameiurus melas*) white sucker (*Catostomus commersonii*) brook stickleback (*Culaea inconstans*) river carpsucker (*Carpiodes carpio*) banded killifish (*Fundulus diaphanus*)	10% of assessed bait shops tested positive for invasive species, and 12% for non-advertised species
McEachran et al. 2021 (*14*)	2014–15 (MN)	qPCR analysis to detect viral and bacterial pathogens Laboratory dissection to detect parasites	Several non-target fish and frog species Viral pathogens: Astrovirus Betanodavirus Circovirus Golden shiner picornavirus-1 Golden shiner picornavirus-2 Golden shiner totivirus Piscine Mycocarditis-like Virus Other microbial pathogens: Numerous, including the important microsporidian *Ovipleistophora ovariae* and the important salmonid pathogens *Aeromonas salmonicida* and *Yersinia ruckeri* Parasites: *Chilodenella* spp. *Dactylogyrus* spp. *Epistylis* spp. *Gydrodactylus* spp. *Ichthyophthirius multifillis* *Ichthyobodo* spp. Neascus spp. Trichodina spp.	45% of golden shiner samples contained non-target fish or frog species 51% of samples contained external parasites, including the first record of *O. ovariae* in Minnesota Additional detections of viral and bacterial pathogens

Snyder et al. 2020 (*15*)	2016–17 (OH, MI, IN)	eDNA and morphological analysis to detect unadvertised fish species	11 aquatic invasive species (Eurasian ruffe, silver carp, bighead carp, and others) 13 non-bait native species (juvenile walleye, yellow perch, white sucker, and others)	Unadvertised species were present in 100% of sampled bait shops, including aquatic invasive species (88% of shops) and native non-bait species (61% of shops)
Stepien et al. 2019 (*16*)	2016–17 (Great Lakes region, states not reported)	eDNA to detect invasive cyprinid fish species	silver carp (4 shops) bighead carp (1 shop) goldfish (7 shops) grass carp (4 shops) common carp (5 shops) Shops sampled = 48	
Boonthai et al. 2018 (*17*)	2015–16 (MI)	PCR to identify viral pathogens	golden shiner reovirus (GSRV) (8 lots) fathead minnow nidovirus (FHMNV) (9 lots) viral hemorrhagic septicemia virus (VHSV) (1 lot) Lots examined = 90	
Mahon et al. 2018 (*18*)	2012–13 (IL, IN, MI, MN, NY, OH, PA, WI)	eDNA to screen for a specific list of 12 pathogens	*Vibrio* (68% of samples) *Legionella* (89% of samples) *Mycobacterium* (97% of samples) *Coxiella (*7% of samples) *Campylobacter* (5% of samples) *Francisella* (18% of samples) *Plesiomonas* (1% of samples) *Flavobacterium* (100% of samples) *Aeromonas* (99% of samples)	
Boonthai et al. 2017 (*19*)	2015–16 (MI)	Morphological analysis and PCR analysis to identify the Asian fish tapeworm	Asian fish tapeworm (*Schyzocotyle acheilognathi*)	53% of sampled fish lots tested positive (1 lot = 60 fish) Within lots, prevalence was 20% for emerald shiners, 8.3% for golden shiners, 1.3% in sand shiners, and none in fathead minnows.
Nathan et al. 2015 (*20*)	2012–13 (IL, IN, MI, MN, NY,	eDNA to screen for a specific	Silver carp (*Hypophthalmichthys molitrix*)	4.7% of samples tested positive

	OH, PA, WI)	list of six aquatic invasive fish species	Round goby (*Neogobius melanostomus*) Tubenose goby (*Proterhinus semilunaris*) Eurasian rudd (*Scardinius erythrophthalmus*) Goldfish (*Carassius auratus*)	for at least one target species Sampled shops usually corresponded to exactly one sample, though a minority were sampled multiple times
Mahon et al. 2014 (*21*)	2012 (IL, OH, MI, WI)	eDNA to detect unadvertised fish species	Spottail shiner (*Notropis hudsonius*) Mimic shiner (*Notropis volucellus*) Sand shiner (*Notropis straminenus*) White perch (*Morone americana*) Black bullhead (*Ameirurus melas*) Finescale dace (*Chrosomus neogaeus*) Brook stickleback (*Culaea inconstans*) Numerous unknown fish species	Out of 6 shops, 3 tested positive for at least one of these specific species, and the remaining 3 returned sequences from unknown fish
McCann 2012 (*22*)	c. 2011–12 (WI)	PCR to identify viral pathogens	Golden shiner virus Fathead minnow nidovirus 15 unknown viruses	44% of lots tested positive for at least one of the target viruses (1 lot = 60 fish from the same water source)
DiStefano et al. 2009 (*8*)	2003–04 (MO)	Taxonomic identification of crayfish	Invasive crayfish species: *Orconectes rusticus* *Orconectes nais* Illegal native crayfish species: *Orconectes immunis* Several other species, including multiple unidentified crayfish	Bait shop owners typically could not identify crayfish species

3.4. Challenges with existing initiatives

Certification

The State of Colorado's Aquatic Nuisance Species Management Plan report points out that lack of capacity to perform inspections in bait shops contributes to risk of aquatic invasive species in the state (*4*).

Some states, most notably Arkansas, conduct testing and certification of baitfish produced in aquaculture. This is a positive step. However, even when baitfish are sourced from out-of-state farms that conduct testing for specific taxa, there have been instances where baitfish are still associated with pathogens or aquatic invasive species (*7*, *13*, *20*). This indicates that certification does not eliminate the risk of disease transmission or invasive species.

The 2018 report from the Minnesota Department of Natural Resources highlights the risks associated with importing minnows, such as golden shiners, from Arkansas (*23*). The report states that these baitfish, despite being certified, cannot be considered "pathogen-free" or "invasive species-free."

Certification in baitfish-producing states mainly focuses on known pathogens and may overlook emerging or unidentified diseases (*24–27*). This exacerbates concerns about the risk of cross-state transmission of organisms, even with certified baitfish.

Furthermore, a number of invasive aquatic species or destructive pathogens are only tested upon request. Concerns also extend to the lack of verifiable chain of custody from certified farms to bait retailers (*23*). This latter issue indeed appears relevant to Colorado; as we discussed above, the Colorado government keeps records of the importation of fish, but these records do not allow for baitfish to be attributed to their ultimate source.

These problems were demonstrated by an incident in Vermont, where an angler noticed mosquitofish in his bait bucket (*28*). The bait was traced to a wholesaler who had originally obtained the bait from a fish farm in Arkansas that participates in a certification program. Since the mosquitofish were noticed informally and at a very late stage (in an angler's bait bucket), it is reasonable to hypothesize that unintended organisms may routinely escape notice even in certified bait.

Awareness-raising and education

Some states have attempted to reduce the risk of aquatic invasive species and pathogens by raising awareness among the angler community. However, results of such initiatives are mixed. One study on this topic concluded that high-risk behavior (e.g. releasing bait at the end of a fishing trip) is very difficult to predict and that outreach strategies (e.g. education) "are likely ineffective" (*29*).

Indeed, in our recent survey of Colorado's anglers, many respondents reported releasing the leftover fish in the water (18.1% for purchased fish; 17.3% for self-collected fish). This is especially concerning as baitfish purchased in Colorado appear to primarily originate from out of state (see section 2.1).

Modelling studies have demonstrated that even a relatively small proportion of anglers participating in this risky behavior is sufficient to increase the risk of the introduction of aquatic invasive species (*30*, *31*). It only takes a handful of anglers to release bait at the end of a fishing trip (whether this is due to not having been reached by outreach strategies or having deliberately ignored such strategies) to allow aquatic species to establish in Colorado's waterways.

This suggests that effectively safeguarding Colorado's lakes and rivers may require limiting access to imported baitfish rather than relying solely on influencing angler behavior.

3.5 Other sources of fish imported into Colorado

It should be noted that aquaculture facilities and CPW import juvenile fish for aquaculture production and/or stocking. However, the nature of these activities mean that they do not carry the same level of risk as the importation of baitfish, and these two activities also offer larger benefits to the state than the importation of baitfish.

Aquaculture facilities are naturally limited in geographic scope and, by virtue of being managed by professional and experienced aquaculturists, already perform extensive oversight of day-to-day production and management of fish health. Moreover, the majority of aquaculture production within Colorado involves food fish production (especially trout), which does not carry the same risk of establishment of organisms in new water bodies (*32*).

Likewise, while CPW imports some juvenile fish for stocking purposes, much of the state's stocked fish originate in CPW-operated fish hatcheries. This means that CPW has a large amount of oversight and control over fish stocking and any issues can be quickly identified and rectified; this is not the case with the diffuse sale and use of live baitfish by individual anglers, which involves individual shop owners and

individual anglers who usually have neither the capacity nor expertise to conduct regular oversight of live bait.

Moreover, aquaculture production supports the livelihood of business owners inside Colorado, and CPW's fish stocking program is designed to benefit Colorado's wild fish populations and, therefore, the state's anglers. This means that importing fish for these two purposes also brings a much larger benefit to stakeholders within Colorado.

4. Impact of the proposed change to regulation

4.1. Precedent from other states

Most states have some form of regulations on the use of live baitfish (*1*, *9*, *33*). These range from restrictions on the use of baitfish in some specific waterbodies and areas, as in Colorado, to complete bans on the use of live baitfish.

The most extreme regulations impose a complete ban on the use of live baitfish. Such bans exist in Oregon, Washington, Idaho, Utah, and Alaska, and many provinces in Canada (in freshwater). However, regulations need not be so extreme to be effective.

A number of states have implemented bans on the import of live baitfish from other states. This more restrained policy has a number of advantages; for example, anglers can still harvest and use their own baitfish, and aquaculture enterprises within the state can produce baitfish for in-state use. This policy has been adopted in Maine, Minnesota, Montana, and the remaining Canadian provinces that still allow baitfish use (*33*).

4.2. Prevalence of live baitfish use by Colorado's anglers

Live baitfish appears to be the bait of choice only for a minority of Colorado's anglers (Fig. 4). The periodic surveys conducted by CPW found that the percentage of Colorado's anglers who use live baitfish was 20 percent in 2012, 17 percent in 2020, and 13 percent in 2023. This is corroborated by our recent survey, which also found that live baitfish was preferred by 13 percent of anglers (full survey reported in Addendum 3).

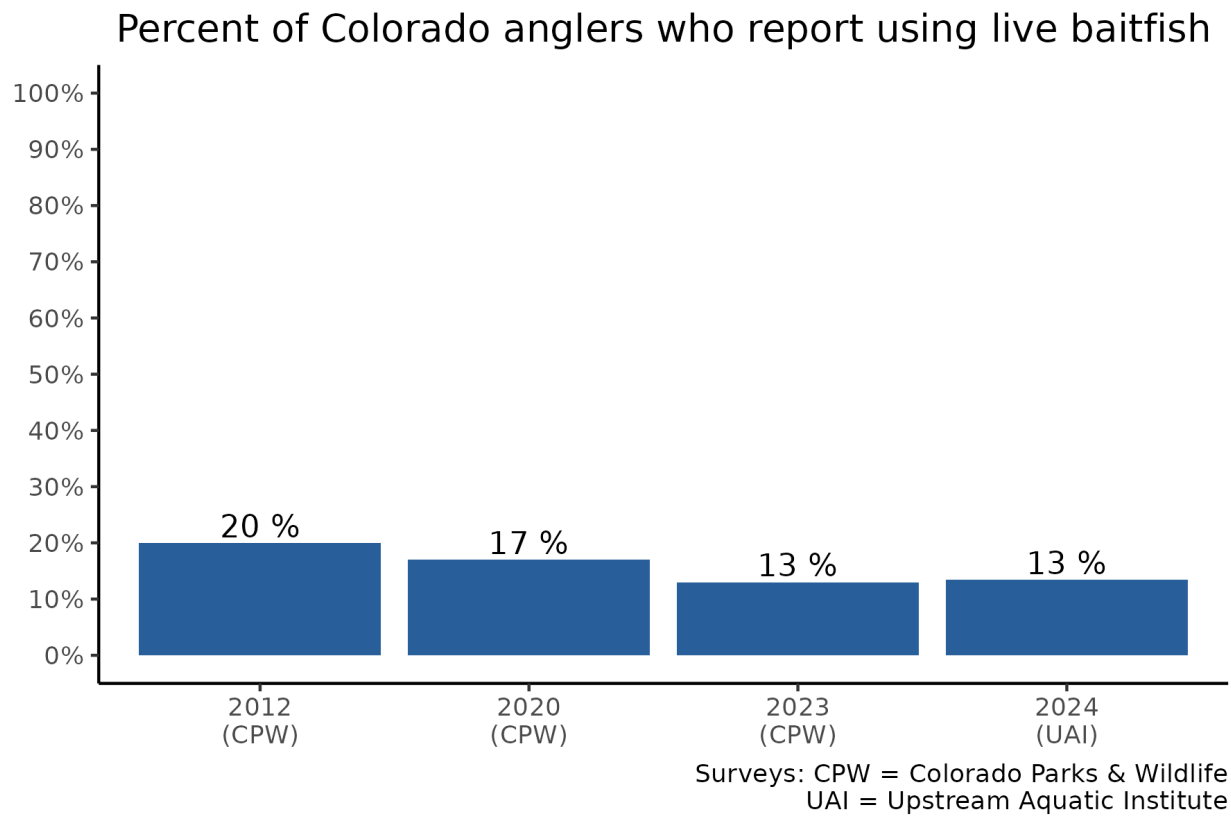


Fig. 4. Preference for live baitfish in Colorado over time.
Data: CPW surveys of anglers (2012, 2020, 2023), UAI survey (2024).

4.3. Colorado anglers' stated response to policy

In our recent survey of Colorado anglers, we asked about support and responses to a few proposed policies (see Addendum 3).

When asked about a proposed policy that would restrict imports of live fish for use as bait from outside Colorado into the state, respondents were more likely to support this proposal (46.2%) than oppose this proposal (24.2%), with a sizable minority being indifferent (31.6%).

When asked how they would respond if they could not purchase live fish for use as bait at all, respondents frequently stated that they would not change their fishing frequency (52%). Respondents faced with this scenario were approximately as likely to report an intention to fish more often (21.0%) than they were to report an intention to fish less often (18.7%).

Together, these results suggest that Colorado's anglers are mostly indifferent about, or somewhat supportive of, these proposed policies. This is unsurprising, given the

relatively low proportion of anglers in Colorado who have a preference for live baitfish (see above).

4.4. Limited economic implications for key stakeholders

We have conducted an economic analysis to discern whether possible restrictions on live baitfish could impact stakeholders in Colorado. The full report is attached as Addendum 2, and we will summarize some key findings here.

To put the benefits of this risk reduction in financial terms, the average cost incurred due to an aquatic invasion in the United States is $7.4 million (*3*). Any potential economic impacts ought to be understood in the context of this reduction in environmental and financial risk.

Overall, the economic implications of proposed regulations to live baitfish on stakeholders in Colorado appear limited. The best available evidence, from both economic studies across the U.S. and our own conversations with local shop owners, suggests that bait and tackle shop owners derive almost all of their revenue from sources other than live bait. The volumes of baitfish sold are invariably low and constitute only a minor proportion of revenue, and it would be reasonable to assume that this revenue would be replaced by alternative bait purchases to some extent. As such, we can be relatively confident that the revenues of local businesses will remain unaffected by a baitfish ban. The evidence supporting these conclusions is discussed in detail in Addendum 2.

We also considered low-income communities in particular; however, live baitfish appears to be a luxury item, most frequently purchased and used by anglers with disposable income. In contrast, low-income anglers tend to use worms and/or source their own bait. This means that low-income anglers are unlikely to experience any disproportionate effects of a baitfish ban. The evidence supporting these conclusions is discussed in Addendum 3.

We have also explored whether additional restrictions on live baitfish could interfere with the general public's engagement in fishing, as recreational fishing is an important source of both economic and recreational value. This hypothesis appears unlikely on initial consideration, given the relatively low proportion of anglers in Colorado who have a preference for live baitfish (see above). Nevertheless, we conducted a separate statistical analysis to formally test whether baitfish regulations in the United States have caused any discernible effect on the public's engagement in fishing (*34*). The statistical analysis did not reveal any evidence that the public's engagement in fishing has been affected by baitfish restrictions. This analysis, which has been published in a peer-reviewed journal, is attached as Addendum 4.

5. Conclusion

Current regulations in Colorado permit the importation and sale of cultured baitfish from outside the state in many areas of Colorado. This poses a significant risk of introducing aquatic invasive species and pathogens into Colorado's rivers and lakes, as demonstrated by the ubiquitous documentation of invasive species, pathogens, and parasites in scientific surveys of baitfish sold across the U.S. Beyond the danger posed to the recreational and amenity value of Colorado's waterways, allowing aquatic invasive species to be introduced to Colorado will necessitate ongoing management programs. These ongoing management programs for other aquatic invasive species are costly in terms of labor and government financial resources.

A regulatory measure can effectively mitigate these risks. In this report, we have proposed two options: prohibition on the use of all cultured baitfish in Colorado, or a prohibition of the import of baitfish into Colorado from out-of-state producers. Either of these measures would help to safeguard Colorado's aquatic heritage.

Multiple lines of evidence suggest that the economic impact of a ban on live baitfish importation would be minimal for Colorado stakeholders. Bait and tackle shops thrive on a diverse range of products and services, and angler surveys and a formal statistical study show that restrictions regarding baitfish have minimal impact on fishing participation. Public opinion, too, largely supports or remains neutral towards such a measure.

To protect Colorado’s aquatic ecosystems and recreational fisheries, CPW is encouraged to evaluate the risks and benefits outlined in this report and consider adopting a prohibition on the importation of live baitfish. This policy represents a prudent and proportionate step to safeguard the ecological integrity and recreational value of Colorado’s rivers and lakes.

6. Addenda

Attached are four documents to support the analysis offered in this report.

1. Copy of the relevant rule with the change made in redline format (CCR Colorado Parks and Wildlife Chapter W-0, Articles I and VII)
2. Report: *The economic impacts of baitfish regulations in Colorado*
3. Report: *2024 Survey of Live Fish as Bait in Recreational Fishing in Colorado: Summary of Results*
4. DeRooy and Hansen 2024, "Untangling the impact of live baitfish restrictions on recreational fishing participation in the United States", *Frontiers in Conservation Science* (5) <available online: https://www.frontiersin.org/journals/conservation-science/articles/10.3389/fcosc.2024.1446550/full>.

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DEPARTMENT OF NATURAL RESOURCES

Colorado Parks and Wildlife

CHAPTER W-0 - GENERAL PROVISIONS

2 CCR 406-0

[Editor's Notes follow the text of the rules at the end of this CCR Document.]

ARTICLE I - DEFINITIONS

#000 - The following definitions supplement the statutory definitions found in the Wildlife Act including, but not limited to, those definitions found in section 33-1-102, C.R.S.

[...]

B. Definitions related to Aquatic Species or Fish Health

1. **"Aquatic Nuisance Species" (ANS)** means exotic or nonnative aquatic wildlife or any plant species that have been determined by the Commission to pose a significant threat to the aquatic resources or water infrastructure of the state.

2. **"Best management practices"** means the most effective, practicable (including technological, economic, constructible, and institutional considerations) means of preventing or minimizing the presence or spread of ANS, parasites, or diseases in a fish production facility.

3. **"Certification"** means a document issued by the Division certifying that the facility and the fish located thereon, have been tested for regulated fish pathogens in the numbers and by methods meeting the minimum standards established by these regulations, or any analogous document issued by a qualified fish health official from a recognized state, federal, or foreign fish and wildlife agency.

4. **"Coldwater stream"**- means a segment or reach of a creek, stream, or river that has water temperatures that do not exceed 68 degrees F for 24 consecutive hours.

5. **"Critical Habitat"**- means the following river reaches and their 100 year floodplains: the Gunnison River downstream of the Uncompahgre River confluence, the Colorado River downstream of the exit 90 north bridge from I-70, the White River downstream of Rio Blanco Dam, the Green River downstream of the Yampa River confluence, and the Yampa River downstream of the Colo 394 bridge.

6. **"Direct connection"** means waters in the Upper Colorado River Basin that flow directly into critical habitat. This does not include reservoirs, and waters above such reservoirs, where fish escapement has been addressed according to a management plan approved by the Division.

7. **"Drainages"**- means sub-sets of the USGS hydrologic code system as set forth in the Hydrologic Unit Maps (U.S. Geological Survey Water Supply Paper 2294, U.S. Dept. of Interior U.S. Geological Survey, 1974, State of Colorado section reprinted 1992). This document, but not later amendments or editions, have been incorporated by reference and can be viewed and copies obtained at the Division as set forth in the "Incorporated References" section of Chapter 0 of these regulations.

8. **"Food Production Facility"** – means any operation which raises or produces fish or crustacean for the purpose of human consumption that the Division, after consultation with the Colorado Fish Health Board, has determined possesses a biosecurity plan and ensures that such fish or crustacean never escapes the facility live.

9. **"Gametes"**- means eggs or sperm.

10. **"Inlets"** - means the bay or recess at the confluence of a stream with the surface of a lake or reservoir.

11. **"Isolated Water"**- means ponds, lakes, or reservoirs that have no outlet.

12. **"*Myxobolus cerebralis* intensity"** means average spore levels in salmonid fish as determined by standardized testing in accordance with the provisions of #014 Aquatic Wildlife Health Management.

13. **"*Myxobolus cerebralis* negative salmonid fish production facility"** means a facility in which Myxobolus cerebralis has never been found or in which *Myxobolus cerebralis* has been eliminated in accordance with the provisions of #014 Aquatic Wildlife Health Management.

14. **"*Myxobolus cerebralis* negative water"** means a lake, pond or coldwater stream segment sampled for a statistically valid number of fish that do not test positive for *Myxobolus cerebralis*, or a water that has not been tested and has not been stocked with salmonid fish from a *Myxobolus cerebralis* positive facility.

15. ***Myxobolus cerebralis* positive water"** means a lake, pond or coldwater stream segment sampled and found to have salmonids that test positive for *Myxobolus cerebralis*, or which has been stocked with salmonid fish from a *Myxobolus cerebralis* positive facility.

16. **"Myxospore (spore)"** means the stage of *Myxobolus cerebralis* formed in the cartilage of infected fish which re-infects the alternate host, the *Tubifex tubifex* worm.

17. **"Nonsalmonid fish"** - means all species of fish and their hybrids that are not in the family Salmonidae.

18. **"Ordinary high water line"**– means the point where perennial, hydrophytic plant life converges with bare substrate (rock, gravel, sand, fines) or with substrate interspersed with annual vegetation.

19. **"Prevalence"** is the percentage of individuals in a population found to be infected with a pathogen as determined by standardized testing in accordance with the provisions of #014 Aquatic Wildlife Health Management.

20. **"Qualified fish pathologist"** means an individual who meets professional standards as set forth by the CPW and who conducts inspections as set forth in #014 Aquatic Wildlife Health Management.

21. **"Salmonid fish"** - means all species of fish and their hybrids in the family Salmonidae, including but not limited to trout, salmon, char, whitefish, and grayling

22. **"Salmonid fish production facility"** - means one or more lakes, ponds, raceways, tanks or other containers in a single location and under the same ownership and management in which salmonid fish are reared for eventual live shipment or release.

23. **"Salmonid habitat"** means any water that supports, is capable of supporting, or is upstream of a water that supports a self-sustaining population of trout, salmon, char, whitefish, or grayling; and includes the drainages listed in Appendix D.

24. **"Spore concentration technique (SCT)"** means tests conducted according to:

a. *"Myxosoma cerebralis:* Isolation and Concentration from Fish Skeletal Element – Sequential Enzymatic Digestion and Purification by Differential Centrifugation", Maria E. Markiw and Ken Wolf, Journal Fisheries Research Board of Canada, Volume 31, No. 1, 1974., or

b. "Whirling Disease *Myxobolus cerebralis* Spore Concentration using the Continuous Plankton Centrifuge", Joseph J. O'Grodnick, Journal of Wildlife Diseases Volume 11 pp 54-57, 1975.

These documents, but not later amendments or editions, have been incorporated by reference and can be viewed and copies obtained as set forth in the "Incorporated References" section of Chapter 0 of these regulations.

25. **"Triactinomyxons (TAMS)"** are a stage of *Myxobolus cerebralis* formed in the gut lining of the *Tubifex tubifex* (tubifex) worm, and which are then released into the water column and re-infect fish with *Myxobolus cerebralis*.

26. **"Upper Colorado River Basin"** - means that portion of the Colorado River drainage that lies within the boundaries of the State of Colorado. This includes all waters in the Yampa, White, Gunnison, Dolores, San Juan, and Colorado River basins.

27. **"100-year floodplain"**- for the upper Colorado River Basin means river floodplain 5.5 vertical feet above the ordinary high water line (OHWL).

28. "**Bait**" means any hand-moldable material designed to attract fish by the sense of taste or smell; those devices to which scents or smell attractants have been added or externally applied (regardless if the scent is added in the manufacturing process or applied afterward); scented manufactured fish eggs and traditional organic baits, including but not limited to worms, grubs, crickets, leeches, dough baits or stink baits, insects, crayfish, human food, fish, fish parts or fish eggs.

[...]

ARTICLE VII - AQUATIC WILDLIFE

#010 – TRANSPORTATION OF AQUATIC WILDLIFE

A. Transportation of Approved Aquatic Wildlife: Only the aquatic wildlife approved under #012 of this regulation may be transported within the State of Colorado. It shall be unlawful for any person to transport any live aquatic wildlife not approved under #012 of this regulation.

B. Requirements for Transportation:

1. All Aquatic Wildlife: All aquatic wildlife being transported within Colorado must at all times be accompanied by, and may only be transported within Colorado pursuant to:

    a. A personal fishing license (including the regulations pertaining to live fish as bait set forth in other provisions of CPW regulations, including #104.H),

    b. A commercial fishing license,

    c. A donation certificate,

    d. A receipt from a commercial or private lake licensee, permitted aquaculture facility or permitted pet animal facility,

    e. An aquaculture facility permit,

    f. A pet animal facility permit,

    g. An importation license,

    h. A scientific collecting license, or

    i. A bill of lading or other similar documentation evidencing that the wildlife is being transported through Colorado for delivery in another state and containing the name, address and phone number of both the source and receiving person or facility.

    Original documentation is only required when transporting aquatic wildlife pursuant to a personal or commercial fishing license, a donation certificate or any kind of receipt. In all other cases, legible copies of the required documents will suffice.

2. Unless otherwise specified under these regulation or under Title 33, all live fish transported within Colorado must be accompanied by a copy of the fish health certificate for the source facility evidencing its compliance with #014 Aquatic Wildlife Health Management, unless the bill of lading or other similar documentation shows that the shipment is being transported through Colorado for delivery in another state. At the Division's discretion, the Division may waive the requirement that a fish health certificate accompany live fish transported in Colorado when transportation occurs from one Food Production Facility to another Food Production Facility.

#011 - IMPORTATION OF AQUATIC WILDLIFE

A. Except as provided in these regulations or authorized by the Division or under Title 33 or Title 35 C.R.S., it shall be unlawful for any person to import any live native or nonnative aquatic wildlife into Colorado.

B. Importation of Approved Aquatic Wildlife: Only the aquatic wildlife approved under #012 of this regulation may be imported. It shall be unlawful for any person to import any aquatic wildlife not approved under #012 of this regulation.

C. Requirements for Importation License:

1. A person must obtain an Importation License from the Division prior to importing any live aquatic wildlife into Colorado.

2. Application for an Importation License shall be made on the form provided by the Division.

3. Properly completed forms and the license fee must be submitted to the Division at least seven (7) working days prior to the proposed importation date.

4. Upon receipt of the Importation License, a person may import only those species and only from the facility listed on the license. Additional species may be added to the license upon written application to the Division at least seven (7) working days prior to the proposed importation date.

D. The Division may inspect any shipment of live crustacean, fish or viable gametes imported into Colorado.

E. Receipt of all wildlife imported must be reported to the Division as specified on the Importation License.

F. All importations of aquatic wildlife must comply with state fish health management regulations. A copy of a facility's health certification, if applicable, must accompany each shipment of live aquatic wildlife.

G. Release of aquatic wildlife must comply with all applicable regulations including but not limited to the restrictions found in #012, # 013 and 014 of these regulations.

H. It shall be unlawful for any person to import any aquatic wildlife for sale or use as bait; or to sell any imported aquatic wildlife for use as bait; or to purchase any imported aquatic wildlife for use as bait.

#012 - POSSESSION OF AQUATIC WILDLIFE

A. Except as provided in these regulations or authorized by the Division or under Title 33 or Title 35 C.R.S., it shall be unlawful for any person to possess any live native or nonnative aquatic wildlife in Colorado.

B. No person shall, at any time, have in possession or under their control any wildlife caught, taken or killed outside of this state which were caught, taken or killed at a time, in a manner, for a purpose, or in any other respect which is prohibited by the laws of the state, territory or country in which the same were caught, taken or killed; or which were shipped out of said state, territory or country in violation of the laws thereof.

C. The following aquatic wildlife may be possessed by any person in the State of Colorado:

1. Amphibians

a. Bullfrogs. Possession of this species is subject to the restrictions set forth in Chapter W-1, #104.H.4 and #107.A.1.m of these regulations.

b. Aquatic gilled forms of tiger salamanders. Possession of this species is subject to the restrictions set forth in Chapter W-1, #104.H.4 and #107.A.1.o of these regulations.

c. Any amphibians allowed under Chapter W-10, #1000.A.6 of these regulations.

d. Any amphibian designated as unregulated wildlife under Chapter W-11, #1103.B of these regulations.

2. Crustaceans

a. The following crustaceans may be possessed east of the Continental Divide:

i. Virile crayfish

ii. Waternymph crayfish

iii. Calico crayfish

iv. Ringed crayfish

v. Southern plains crayfish

b. The following crustaceans may be possessed on either side of the Continental Divide:

i. Freshwater shrimp

ii. Commercially available brine shrimp

iii. Commercially available krill

iv. Subject to the requirements of #010 and #011, red swamp crayfish (*Procambarus clarkii*) for purposes of importing, transporting, or possessing the species for human consumption, provided the following criteria are satisfied:

a. no person may possess an individual of the species alive for more than 72 hours; and

b. any person who possesses the species alive must have:

i. a copy of an importation license issued under #011 that authorizes the importation of the crayfish in the person's possession; and

ii. a receipt or delivery confirmation reflecting the date the person took possession of the crayfish.

3. Fish. Possession of these species is subject to the restrictions set forth in Chapter W-1 of these regulations.

a. Brown, brook, cutthroat, golden, lake and rainbow trout, and their hybrids

b. Arctic char

c. Grayling

d. Kokanee salmon

e. Whitefish

f. Sculpin

g. Smallmouth, largemouth, spotted, striped, and white bass

h. Wipers

i. Common carp

j. Triploid grass carp

k. Bullhead, blue, channel, and flathead catfish

l. Black and white crappie

m. Drum

n. Northern pike

o. Tiger muskie

p. Sacramento and yellow perch, and their hybrids

q. Sauger and saugeye

r. Speckled dace

s. Rainbow smelt

t. Tench

u. Walleye

v. Bluegill and bluegill hybrids

w. Green, redear and pumpkin-seed sunfish

x. Gizzard shad

y. Longnose and white suckers

z. Fathead minnow

aa. Families of fish classified Cyprinidae except for bighead carp, black carp, and silver carp.

bb. Any fish designated as unregulated wildlife under Chapter W-11, #1103.B of these regulations.

D. In addition to those species identified in Chapter W-0, #012.C, any Food Production Facility may possess the following aquatic wildlife in the State of Colorado:

1. Fish

a. Blue tilapia and their hybrids

b. Mozambique tilapia and their hybrids

c. Nile tilapia and their hybrids

d. Barramundi

e. Any other fish that the Division, after consultation with the Colorado Fish Health Board determines can securely be kept within a Food Production Facility and which does not present a risk to native species, their habitat, the aquatic environment, or other Food Production Facilities.

2. Crustacea

a. Redclaw crayfish

E. The possession of any aquatic wildlife in the State of Colorado not listed in this section #012 is unlawful unless otherwise authorized by the provisions of Chapter W-11 of these regulations pertaining to unregulated wildlife, or Chapter W-13 of these regulations ("Possession of Wildlife, Scientific Collecting and Special Licenses"). Any person who takes any fish species from the wild in Colorado not listed in this section may take and possess them year round and in any quantity for personal use, provided that the fish are not listed as nongame, threatened, or endangered under Chapter W-10 and provided that the fish are killed prior to transportation from the point of take.

F. No person shall import, transport, possess, or release any aquatic nuisance species (ANS) except as authorized by the Division or permit issued under Title 35 C.R.S.

#013 - RELEASE OF AQUATIC WILDLIFE

A. Except as provided herein, it shall be unlawful for any person to release any native or nonnative aquatic wildlife in Colorado.

B. Except as otherwise restricted by these regulations, and provided a person possesses the appropriate stocking permit, letter of authorization or commercial or private lake license, the following species are authorized for release in the drainages indicated:

1. All drainages statewide – rainbow, brook, brown, and cutthroat trout (and their hybrids), fathead minnow and certified triploid grass carp.

2. All drainages east of the continental divide – crappie, bluegill, channel catfish, largemouth and smallmouth bass, and green sunfish.

3. All drainages east of the continental divide and outside of salmonid habitat - tiger muskie, walleye, gizzard shad, yellow perch, and wipers.

C. Owners or lessees of property may release or otherwise provide for or allow the release of any of the above species of fish into waters of the state (flowing or standing) located on property they own or lease provided they have obtained a stocking permit, or a commercial or private lake license from the Division, or if such activities are performed by a Colorado permitted aquaculture facility or licensed aquatic wildlife importer, unless the person is exempt under Chapter 12, to release such fish. Stocking permits and lake licenses will be approved or denied based on compliance with all other applicable regulations and a determination by the Division that such stocking will not otherwise negatively impact management of the state's wildlife resources.

D. Licensed aquaculturists may release any species listed in #013.C of these regulations into waters of the state (flowing or standing), upon receipt of an annual letter of authorization from the Division to be sent upon issuance or renewal of the aquaculture license, provided that such release is in accordance with the provisions of regulations #011, #012 , #013 and #014, and provided that aquaculturists submit an annual report on a form provided by the Division, containing information regarding the facility of origin, date, species, size, number and stocking location of all non-salmonid fish, other than certified triplod grass carp and fathead minnow, released into waters west of the Continental Divide by the aquaculturist in the previous calendar year. Provided further, however, that the stocking of the following species is allowed only if the owner or lessee of the property first obtains a stocking permit, or private or commercial lake license, for that purpose from the Division:

1. Non-salmonid species, in the Upper Colorado River Basin, except for fathead minnow and certified triplod grass carp into ponds, lakes or reservoirs outside of critical habitat.

2. Northern pike, or tiger muskies, or prohibited species, anywhere in the state.

3. Salmonid species in the mainstem of the Colorado River below Windy Gap Reservoir downstream to the confluence with the Williams Fork River.

4. Any fish in native cutthroat waters.

The waters identified in Appendix C, including the upstream tributaries and drainages, are designated as stocking restricted cutthroat trout waters. Maps and a copy of Appendix C will be provided to all fish production facilities and with each salmonid importation permit issued by the Division.

E. Except as otherwise provided in these regulations for the Upper Colorado River Basin, certified triploid grass carp may be released into waters of the state in accordance with the following restrictions:

1. All shipments of certified triploid grass carp must be accompanied by a copy of the original certificate of triploidy issued by the U S Fish and Wildlife Service for that lot of fish.

    i. Diploid grass carp may be transported through Colorado only when the destination is another state.

2. Certified triploid grass carp may only be released into standing water or irrigation ditches east of the Continental Divide, except in the Rio Grande Basin.

3. West of the Continental Divide and in the Rio Grande Basin:

    a. Only certified triploid grass carp may be released into standing waters and must be at least eight inches in length at the time they are released.

    b. Such waters must be screened prior to stocking to prevent escape of fish. All screens shall be maintained so as to prevent such escape, and at least one measurement of the gap size shall not exceed one & one-quarter (1 1/4) inch. All such screens may be inspected on an annual basis by the Division or its designated representative.

c. Certified triplod grass carp to be held in aquaculture facilities west of the Continental Divide and in the Rio Grande Basin must be a minimum of 8" in length at the time they are placed in the facility. Any undersized fish that are inadvertently present in a shipment must be removed or handled in a manner to ensure that such fish cannot escape from the facility

F. Upper Colorado River Basin

1. Except as provided herein, no person shall release any species or subspecies of fish within the Upper Colorado River Basin.

a. Rainbow, brook, brown, and cutthroat trout (and their hybrids) may be released within the Upper Colorado River Basin pursuant to a licensed aquaculturist's letter of authorization, except in those river reaches defined as critical habitat.

b. Fathead minnow or triploid grass carp may be released into ponds, lakes or reservoirs outside of critical habitat pursuant to a licensed aquaculturist's letter of authorization as described in #013.D of these regulations.

c. Except as provided in #013.F.1.b of this regulation, stocking of nonnative, nonsalmonid fishes in private waters must be approved by the Division on a case-by-case basis after receipt of a stocking permit application to evaluate potential negative impacts to the state's wildlife resources. Stocking permit applications must include, at a minimum:

1. Location of the proposed stocking.

2. Species, sizes, numbers, and rationale for selecting the desired species.

3. Specific measures to be implemented to reduce the risk of escapement.

d. Except as provided below, stocking of nonnative, nonsalmonid fish species within critical habitat or in a body of water having direct connection to critical habitat of the Upper Colorado basin is not allowed.

1. The stocking of nonnative, nonsalmonid fish species into private waters is allowed if the water is bermed and the outlet is screened according to the specifications of these regulations prior to stocking. Provided further that stocking of fathead minnows within critical habitat is only allowed if the entire perimeter of the water is bermed according to the specifications of these regulations, with no inlet or outlet of any type. A screen or berm is not required when stocking fathead minnows outside of critical habitat.

2. No screening or berming is required to stock trout.

3. Where berms and/or screens are required, private waters must be screened and bermed according to the following standards, and must be approved by the Division prior to stocking.

a. When screens are required, at least one measurement of the gap size shall not exceed one-quarter (1/4) inch, except as provided above.

b. Minimum berm standards are as follows:

i. The berm must be designed and constructed in accordance with recognized and accepted engineering practices.

ii. The berm must be capable of withstanding the hydrodynamic and hydrostatic forces and the effects of buoyancy associated with a 100-year flood.

iii. The berm must be 5.5 vertical feet above the ordinary high water line.

iv. Prior to stocking, the Division may require that all berms be certified in writing as meeting these standards by a licensed engineer. The report shall be submitted to the Division and shall include a consideration of depth and duration of flooding, floodplain elevation, berm geometry, berm and foundation materials, berm compaction, penetrations, and other factors affecting penetrations, localized river channel constrictions and conditions, and any other factors which may affect the ability of the berm to withstand flood events.

4. Except for the annual inspection that may be required by these regulations, stocking of a previously-approved species in a previously-approved water may continue under its initial authorization with no subsequent approval provided all berms and screening continue to prevent escapement of fish. If failure of the berm(s) or screen(s) to prevent escapement occurs, stocking of that water will require Division review and new Division approval prior to additional stocking.

5. Nonnative, nonsalmonid fish species may be released into receiving waters located above existing reservoirs where populations of that species exist and the reservoir is managed according to a management plan approved by the Division, and the management plan allows for the species to be released.

2. Smallmouth bass and northern pike may be released within the Upper Colorado River Basin, except in critical habitat, and then only if:

a. The fish are acquired within the basin from an existing population within critical habitat; and

b. The receiving water already contains the species and is isolated or its outlets are screened to prevent the escape of the fish or their progeny.

All such relocations of fish must be authorized in advance and in writing by the Division.

3. All ponds, lakes or reservoirs within the Upper Colorado River Basin which require, or rely upon, berms or screens to prevent the escape of stocked fish and their progeny may be inspected on an annual basis by the Division or its designated representative. All berms and screens shall be maintained to prevent the escape of fish and their progeny.

4. Except as otherwise prohibited by these regulations, isolated private waters having no direct connection to critical habitat and that are above the 100-year floodplain can be stocked under the authority of a licensed aquaculturist's letter of authorization as described in #013.D of these regulations.

G. Release of aquatic wildlife must comply with all applicable regulations including but not limited to the restrictions in #011, #012, and #014 of these regulations.

#014 – AQUATIC WILDLIFE HEALTH MANAGEMENT

A. Inspection and Certification for Prohibited and Regulated Fish Diseases

1. Annual fish health inspections and certifications are required for all in-state fish production or holding facilities, which sell or stock live fish, and out of state facilities importing live fish into Colorado. A fish health certification will terminate one year from the effective date of certification or upon discovery of a prohibited or regulated disease, whichever occurs first. However, provided the facility requests its annual fish health inspection within 12 months of the effective date of its last certification, its fish health certification shall be valid for fifteen months or whenever its subsequent inspection report is available, whichever occurs first. In the absence of a timely written request for an annual fish health inspection the fish health certification shall terminate 12 months from the effective date of its last certification. A copy of such certification must accompany each fish shipment within or into Colorado.

2. All such facilities shall be annually inspected by a qualified fish pathologist for both prohibited and regulated diseases as applicable.

a.Prohibited diseases

1. All salmonid facilities must be certified to be free of the following diseases:

Infectious Hematopoietic Necrosis Virus (IHNV)
Viral Hemorrhagic Septicemia Virus (VHSV)
Oncorhynchus masou Virus (OMV)

2. All non-salmonid fish production or holding facilities, and any non-salmonid fish being exported from or imported to Colorado, must be certified free of Viral Hemorrhagic Septicemia Virus (VHSV).

3. Inspection and Certification for Other Diseases of Concern: susceptible or potentially susceptible species from all importing facilities within the applicable endemic disease areas, including both salmonid and nonsalmonid fish production or holding facilities, must also be annually certified by a qualified fish pathologist to be free of the following diseases:

Ceratomyxa shasta (Ceratomyxosis)
Epizootic Epitheliotropic Disease
(EEV) Infectious Salmon Anemia Virus
(ISAV) *Piscirickettsia salmonis*
Tetracapsula bryosalmo (Proliferative Kidney Disease – PKD)
Spring Viremia of Carp Virus (SVCV)

b. Regulated diseases – all salmonid facilities must be certified for the presence or absence of the following diseases:

Myxobolus cerebralis (Whirling Disease – WD)
Renibacterium salmoninarum (Bacterial Kidney Disease - BKD)
Aeromonas salmonicida (Furunculosis)
Infectious Pancreatic Necrosis Virus (IPNV)

3. Testing procedures.

a. Except for Viral Hemorrhagic Septicemia Virus (VHSV) and as otherwise provided in these regulations, all inspections and testing procedures must be conducted as set forth in AFS-FHS (American Fisheries Society-Fish Health Section). 2014. FHS blue book: suggested procedures for the detection and identification of certain finfish and shellfish pathogens, 2020 edition. Accessible at: https://units.fisheries.org/fhs/fish-health-section-blue-book-2020/. This document can be viewed and copies obtained at the Division as set forth in the "Incorporated References" section of Chapter 0 of these regulations.

b. Testing for Viral Hemorrhagic Septicemia Virus (VHSV) shall be conducted by the protocols and procedures of:

1AFS-FHS (American Fisheries Society-Fish Health Section). 2014. FHS blue book: suggested procedures for the detection and identification of certain finfish and shellfish pathogens, 2020 edition. Accessible at: https://units.fisheries.org /fhs/fish-health-section-blue-book-2020/. or

2. The Manual of diagnostics for aquatic animals 2021 edition. of the OIE - World Organisation for Animal Health, 12 rue de Prony 75017 Paris, France.

These documents can be viewed and copies obtained at the Division as set forth in the "Incorporated References" section of Chapter 0 of these regulations.

4. Authority to exempt applicants from specific pathogen testing is granted to the Director, upon consultation with, review, and recommendation from the Fish Health Board, when the following criteria are met:

a. Compliance with testing requirements would result in an unacceptable impact on the sample population.

b. There is minimal risk of introducing an exotic pathogen into the state.

c. There is minimal risk of exposing free-flowing waters to any specific pathogen.

d. Adequate provisions for management and disposition of the fish and adequate disinfection of the water as necessary are made and incorporated as conditions of the importation permit.

Application for such an exemption shall be submitted to the Division at least fourteen (14) working days prior to the proposed importation date. The Director shall have fourteen (14) working days to approve or disapprove the application. The Fish Health Board shall review and submit its recommendation to the Director within seven (7) working days after receipt from the Division.

B. Reportable Diseases: the presence of any prohibited or regulated disease at an in-state or importing facility shall be immediately reported to the Division.

C. Management of Prohibited and Regulated Fish Diseases.

1. Prohibited Disease agents.

a. No fish or gametes (eggs and sperm) with, or exhibiting clinical signs of, any Prohibited Disease, or any other infectious agents determined by the Director to pose a significant threat to Colorado's aquatic resources, may be imported or placed in waters of this state without written approval of the Director. Written approval may be granted only after the following conditions have been met:

1. The Director has determined that no damage or undesirable effects to existing fish populations and their habitat will occur.

2. The nature of any disease(s) must be positively determined and documented.

b. If fish are found with Prohibited Diseases or any diseased wildlife, which would have a significant detrimental effect on Colorado's wildlife resource as determined by the Director, are found at any fish production or holding facility they may be destroyed or held in quarantine at the owner's expense, in accordance with 33-5.5-102 C.R.S. Possession, transfer or any other act relative to such wildlife contrary to the Director's determination of disposition is prohibited.

c. The Director shall determine when destruction of wildlife, a quarantine or disinfection is required at any federal, state, private or commercial fish or wildlife production facility. If the Director determines that either destruction, quarantine or disinfection is required, he shall issue a written order to the owner or operator of the facility setting forth the steps for destruction and/or disinfection. Required disinfection of holding facilities will be completed at the owner's expense. If the owner disagrees with the Division's determination he shall have the right to appeal the decision to the Wildlife Commission provided notice of such appeal is given to the Director within seventy-two (72) hours of receipt of the order.

2. Regulated Disease Agents

a. *Myxobolus cerebralis* (Whirling Disease – WD)

1. *Myxobolus cerebralis* testing

a. At the time of the annual inspection for whirling disease certification, all facilities in Colorado or facilities importing fish into Colorado shall be tested using either of the two methodologies listed below.

1. Spore Concentration Technique: The facility shall provide at least one lot of live salmonids (minimum lot size of 260 fish) for whirling disease testing. As a screening procedure, fish shall be tested for the presence of *Myxobolus cerebralis* using a spore concentration technique ("SCT"). Minimum sample size of lots in aggregate shall be determined at the assumed prevalence level of 5% with 95% confidence.

    a. Any negative finding will be conclusive for the absence of *Myxobolus cerebralis*.

    b. Any positive finding will be presumptive for the presence of *Myxobolus cerebralis*. All presumptive SCT findings shall be confirmed by PCR. PCR results shall be conclusive as to the presence or absence of *Myxobolus cerebralis*.

2. Polymerase Chain Reaction (PCR) Technique: As an alternative to SCT, susceptible salmonids held at least 4 months in the water supply may be tested by PCR. A positive finding in such instance shall be considered presumptive for the presence of *Myxobolus cerebralis*. Confirmation shall be determined by a second PCR conducted by a different laboratory.

b. Sample size – for the purpose of annual inspections for *Myxobolus cerebralis*, the minimum sample size for determination of prevalence shall be sixty susceptible fish per water supply in a fish production facility.

c. Stocking from facilities which are presumptive for *Myxobolus cerebralis*.shall comply with the provisions of release of *Myxobolus cerebralis* positive fish during confirmatory testing. PCR tests for presumptive positives will be the highest priority for testing and every effort will be made to complete the test within 21 days.

d. For the purpose of conducting confirmatory testing, should it become necessary, at least 100 fish from each lot tested, with at least 200 total fish from tested lots, shall be held at the facility for up to 3 weeks after the initial inspection date.

e. Diagnostic or incidental observations of *Myxobolus cerebralis* by histology (presence of morphologically correct organisms within salmonid skeletal tissues) shall be presumed positive for the organism. Presumptive findings by histology shall be confirmed by PCR.

2. WD Negative Recertification: In order for the *Myxobolus cerebralis* status of a salmonid fish production facility to change from positive to negative, the owner and/or operator of the facility must complete all of the requirements of either aa or bb below:

a. Method 1 - Facility modifications and testing for *Myxobolus cerebralis*:

1. Render all originating water sources at the facility free of all fish and enclosed so as to prevent outside contamination by *Myxobolus cerebralis*.

2. Construct all rearing spaces and water conveyances of concrete, fiberglass, steel, or other manufactured impermeable materials that are not conducive to colonization by the alternate oligochaete host(s) of *Myxobolus cerebralis*.

3. Completely purge all sediments from rearing spaces and water conveyances at least once every two months.

4. After completion of steps 1 through 3, have the facility tested and found negative for *Myxobolus cerebralis* according to the following procedures and schedule:

a. A minimum of three hundred rainbow trout at least four months of age shall be designated as the sentinel lot and must be individually marked by a state fish pathologist. These fish will then be placed in approved rearing spaces selected for optimal exposure, at which time the exposure period shall begin.

b. Fish shall be collected and tested for *Myxobolus cerebralis* by a qualified fish pathologist during two inspections. A minimum of sixty fish from the sentinel lot, still bearing the previously placed tags, shall be included in each sample. The inspections shall occur at least ten months and at least fourteen months after the exposure period begins if a Spore Concentration Technique (SCT) is used. The testing shall occur at least 8 months and at least 12 months after the exposure period begins if Polymerase Chain Reaction (PCR) is used as the testing technique. The time frame for such testing by PCR may be shortened further if it is determined by the Director after consultation with the Fish Health Board that an additional reduction of the time frame for testing would present a negligible risk of not detecting the presence of *Myxobolus cerebralis*, after consideration of the following criteria:

1. Water supply(s).

2. Distance between water supply(s) and rearing spaces.

3. Nature of connecting pipes and conveyances.

4. Possibility of fish entering and exiting in water supply lines.

5. Nature and construction of rearing spaces.

b. Method 2 - Testing for *Myxobolus cerebralis* with partial or no facility modification.

1. A minimum of three hundred rainbow trout at least four months of age shall be designated as a sentinel lot, and must be individually marked by a qualified fish pathologist. These fish will then be placed in approved rearing spaces selected for optimal exposure to *Myxobolus cerebralis*, at which time the exposure period shall begin.

2. Fish shall be collected and tested for *Myxobolus cerebralis* by a qualified fish pathologist during four inspections. A minimum of sixty fish from the sentinel lots, still bearing the previously placed tags, shall be included in each sample. The inspections shall occur at least ten, fourteen, twenty-four, and twenty-eight months if SCT is used, or at least eight, twelve, twenty, and twenty-four months if a PCR is used as the testing technique after the exposure period begins. A second sentinel lot will be placed in the same rearing spaces after collection of the fourteen month sample for SCT or twelve month sample for PCR. The time frame for testing by PCR may be shortened further if it is determined by the Director that an additional reduction of the time frame for testing would present a negligible risk of not detecting the presence of *Myxobolus cerebralis* after consideration of the following criteria:

a. Water supply(s).

b. Distance between water supply(s) and rearing spaces.

c. Nature of connecting pipes and conveyances.

d. Possibility of fish entering and exiting in water supply lines.

e. Nature and construction of rearing spaces.

f. Nature and reliability of treatment technology.

g. System redundancy and back-up power supply.

3. Sampling in these inspections will be conducted at a minimum assumed prevalence level of five percent at the ninety-five percent level of confidence per lot at least eight months old; and at a minimum assumed prevalence level of two percent at the ninety five percent level of confidence for the facility as a whole.

c. Upon satisfactory completion of the requirements under either Method I or Method II, the State Fish Pathologist shall provide certification of negative *Myxobolus cerebralis* status.

3. Operation of *Myxobolus cerebralis* Positive Fish Production Facility.

a. No person shall operate a fish production facility which has been diagnosed positive for *Myxobolus cerebralis* in salmonid habitat unless an exemption allowing such operation has been granted by the Director after consultation with the Fish Health Board.

1. Applications for such exemptions shall be evaluated based on the following factors:

a. The ability of the facility to remediate and regain *Myxobolus cerebralis* negative status, and any Whirling Disease Clean-up Plan (WDCP) submitted by the applicant;

b. The risk to native cutthroat trout management habitats;

c. The risk to any other salmonid habitats;

d. The risk to any recreationally valuable salmonid fishery;

e. Social and economic impacts to private and public entities, and

f. The Whirling Disease Management Plan (WDMP) submitted by the applicant.

b. Applications for exemptions to operate a *Myxobolus cerebralis* positive facility within salmonid habitat shall be submitted to the Director within 60 days of notification that the facility has tested positive for *Myxobolus cerebralis*. Persons that submit timely applications for exemptions shall be allowed to continue operation, subject to all other applicable regulations, pending the Director's decision. Persons that fail to submit a timely application or have their application for exemption denied shall cease all fish production operations and shall dispose of the fish located on the facility within 180 days or, if the 60 day notice period runs or the application is denied after April 1st, by October 1st of the following year.

c. All applications shall include a Whirling Disease Management Plan (WDMP) and, if the applicant intends to undertake facility remediation, a Whirling Disease Clean-up Plan.

d. The WDMP shall include the best management practices (BMP) to be used to minimize the discharge of spores and TAMS into waters of the state should the facility be allowed to continue operation while positive for *Myxobolus cerebralis*, including any temporary operation while the applicant undertakes clean-up of the facility.

1. BMP's for fish production facilities shall, at a minimum, specifically describe or address the following factors:

a. The *Myxobolus cerebralis* status of fish brought onto the facility;

b. The size of fish brought onto the facility;

c. The size of fish introduced into earthen ponds;

d. Facility construction and operation;

e. Disinfection procedures;

f. Disposition of mortalities;

g. Species to be reared;

h. Treatment of effluent;

i. Exposure of vulnerable-sized fish to temperatures optimum for TAM production;

j. Monitoring of effluent for spore/TAM levels, and;

k. Any other site specific or disease considerations.

e. Persons granted an exemption to operate a *Myxobolus cerebralis* positive facility within salmonid habitat shall:

1. Comply at all times with the terms and conditions of any exemption granted by the Director, including, but not limited to, compliance with WDMP and the BMPs approved for the facility;

2. Submit an annual report to the Division by the anniversary date of the exemption. The annual report shall address operation of the facility and compliance with terms and conditions of the exemption. An annual site inspection may be conducted to determine compliance with the terms and conditions of the exemption.

f. Exemptions granted by the Director shall be valid unless the applicant fails to comply with the terms of the exemption, fails to submit an annual report, or new and significant information regarding the risks associated with continued operation of the *Myxobolus cerebralis* positive facility, or the availability of BMPs which would improve management of the infection, supports modification of the WDMP and the exemption or revocation of the exemption.

4. Release of *Myxobolus cerebralis* Positive Fish

a. No live salmonid originating from a facility which has been diagnosed positive or presumptive for *Myxobolus cerebralis* may be released into salmonid habitat unless an exemption allowing such stocking has been granted by the Director after consultation with the Fish Health Board.

b. Applications for exemptions shall be submitted to the Director at least 60 days prior to any proposed stocking.

c. Applications for stocking exemptions shall be evaluated based on the following factors:

1. The risk to native cutthroat trout management habitats, any other salmonid habitats or any recreationally valuable salmonid fishery, including consideration of:

a. M.c. status of free-ranging fish in the water proposed for stocking;

b. Proximity to native cutthroat trout waters or planned cutthroat trout recovery areas;

c. Size and species of salmonids to be stocked;

d. The prevalence or intensity of *Myxobolus cerebralis* infection in and the total number of salmonids to be stocked;

e. Connection of the water proposed for stocking to other public or private water at any time during the year;

f. The presence of naturally reproducing salmonid species in connected waters;

g. The prevalence or intensity of *Myxobolus cerebralis* infection, if any, in naturally reproducing salmonid populations present in connected waters;

h. The presence and *Myxobolus cerebralis* status of fish production or distribution facilities in connected waters;

i. The physical and operational, if an impoundment, characteristics of the water to be stocked;

j. Any other factor which determined by the Director to be important in determining the risk to fish or fish habitat.

2. Social and economic impacts to private and public entities, and;

3. The Whirling Disease Management Plan (WDMP) submitted by the applicant.

d. All applications for stocking exemptions shall include a Whirling Disease Management Plan (WDMP). The WDMP shall include the best management practices (BMP's) to be used to minimize the discharge of spores and TAMS to waters of the state due to the stocking of the fish. BMP's for fish stocking shall, at a minimum, specifically describe or address the following factors:

1. Size of *Myxobolus cerebralis* positive fish to be stocked;

2. Species of *Myxobolus cerebralis* positive fish to be stocked;

3. Facility construction and operation;

4. Disinfection procedures;

5. Disposition of mortalities;

6. Treatment of effluent;

7. Exposure of vulnerable-sized fish to temperatures optimum for TAM production;

8. Monitoring effluent for spore/TAM levels, and;

9. Any other site specific or disease considerations.

e. Persons granted a stocking exemption shall:

1. Comply at all times with the terms and conditions of any exemption granted by the Director, including, but not limited to, compliance with WDMP and the BMPs approved for the stocking.

2. Submit an annual report to the Division on the anniversary date of the exemption. The annual report shall address compliance with terms and conditions of the exemption. An annual site inspection may be conducted to determine compliance with the terms and conditions of the exemption.

f. Exemptions granted by the Director shall be valid unless the applicant fails to comply with the terms of the exemption, fails to submit an annual report, or new and significant information regarding the risks associated with the stocking of *Myxobolus cerebralis* positive fish, or the availability of BMPs which would improve management of the infection, supports modification of the WDMP and the exemption, or revocation of the exemption.

b. *Renibacterium salmoninarum* (Bacterial Kidney Disease - BKD)

1. Bacterial Kidney Disease Management Plans: No later than 60 days of finding and notification that an in-state fish production facility is positive for *Renibacterium salmoninarum*, the owner shall submit a written management plan to the Fish Health Board and to the Director. The plan shall address possible sources of infection, species of fish, types of rearing containers, disinfection, eradication and avoidance of recurrence of the pathogen, and the proposed disposition of positive fish. Within 30 days after submittal, the Fish Health Board shall review the plan and submit it with a recommendation for approval, rejection or modification to the Director. The Director shall then have 15 days to approve, reject, or modify the plan. Before making a final decision, the Director will consider the recommendation of the Fish Health Board and the effectiveness of the plan in controlling and managing the pathogen in the fish production facility.

2. Re-establishment of Negative Status for BKD: In order for the *Renibacterium salmoninarum* status of a fish production facility or free-ranging fish population to change from positive to negative, the owner and/or operator of the facility must complete all of the requirements of either a or b below:

a. Method 1 - Testing for *Renibacterium salmoninarum* without depopulation:

After twelve months and the completion of three consecutive negative inspections at least three months apart, aqualified fish pathologist shall provide notification that the facility or population is considered negative for *Renibacterium salmoninarum*.

b. Method 2 - De-population of lots testing positive and testing for *Renibacterium salmoninarum*:

After de-population of lots testing positive and the completion of two consecutive negative inspections at least three months apart, the qualified fish pathologist shall provide notification that the facility or population is considered negative for *Renibacterium salmoninarum*.

3. No person shall release into any fish production facility or into any waters of this state live salmonid fish or gametes from a free-ranging fish population or fish production facility which is positive for *Renibacterium salmoninarum*, (the causative agent of Bacterial Kidney Disease) except as allowed herein.

   a. Release is limited to waters and fish production facilities approved by the Director. Waters will not be approved if such stocking is determined to be a significant threat to:

      1. any other federal, state, or permitted fish production facility; or

      2. stocking restricted cutthroat trout waters identified in Appendix C; or

      3. any other free-ranging salmonid fish populations determined to be of special importance to Colorado's fishery resources, considering the uniqueness of the resource, use and/or potential for use as a source of brood fish or gametes.

   A list of approved waters and fish production facilities and the maps indicating the location of stocking restricted cutthroat trout waters are available from the manager of the Aquatic Resources Section of the Division, 6060 Broadway, Denver, CO 80216.

   b. The owner and/or operator of a fish production facility receiving gametes from a free-ranging fish population or fish production facility which is positive for *Renibacterium salmoninarum* shall have the progeny tested for *Renibacterium salmoninarum* prior to movement of the progeny from the facility.

   c. *Aeromonas salmonicida* (Furunculosis): No live salmonid fish originating from a facility which has been diagnosed positive for *Aeromonas salmonicida* (Furunculosis) may be stocked within stocking restricted cutthroat trout waters identified in Appendix C.

      1. A state, federal or licensed aquaculture facility shall be considered negative upon the completion of a negative inspection at least 60 days after a positive diagnosis of *Aeromonas salmonicida* (Furunculosis).

      2. Eggs originating from a facility which has been diagnosed positive for *Aeromonas salmonicida* (Furunculosis) shall be disinfected both at the point of origin and at their destination, using the method as set forth in #014 Aquatic Wildlife Health Management of these regulations.

d. Infectious Pancreatic Necrosis Virus (IPNV): Any aquaculture facility found positive for Infectious Pancreatic Necrosis Virus (IPNV) shall be subject to virus eradication efforts approved by the Director at the owner's expense within one calendar year of the positive finding.

1. No person shall import into Colorado or release into any waters of this state live salmonid fish or gametes (eggs or sperm) from a water or facility in which Infectious Pancreatic Necrosis Virus (IPNV) has been identified without a plan for the eradication of the virus and disposition of affected fish approved by the Director. Upon a positive finding of Infectious Pancreatic Necrosis Virus (IPNV) in an aquaculture facility in Colorado, the owner shall have 60 days to submit a written plan to the Fish Health Board for the eradication of the pathogen and disposition of the fish. The Fish Health Board shall have 30 days to review the plan and submit it with a recommendation for approval, rejection or modification to the Director. Before making a final decision, the Director will consider the recommendation of the Fish Health Board and the effectiveness of the process outlined in the plan to eradicate the pathogen from the aquaculture facility. No salmonid fish or gametes (eggs or sperm) from a water or facility in which Infectious Pancreatic Necrosis Virus (IPNV) has been identified shall be re-leased into any water of this state without an approved plan. In addition, no live salmonid fish or gametes (eggs or sperm) originating from an aquaculture facility or free-ranging fish population which has been diagnosed positive for Infectious Pancreatic Necrosis Virus (IPNV) may be stocked if determined by the Director to be a threat to: (A) any other federal, state or permitted aquaculture facilities or (B) stocking restricted cutthroat trout waters identified in Appendix C or (C) free-ranging salmonid populations used or intended for use as gamete (eggs or sperm) sources for state, federal or permitted aquaculture facilities or (D) any other free-ranging salmonid fish populations determined by the Director to be of special importance to Colorado's fishery resources. Criteria for D will include uniqueness of the resource and potential for use as a source of brood fish or gametes.

2. Aquaculture facilities that have undergone adequate efforts to eradicate IPNV may again be considered negative 90 days after the reintroduction of sentinel fish and upon the completion of two negative inspections on all lots present at least eight weeks apart. For these purposes, sentinel fish shall consist of either rainbow trout or brook trout fry between one day and 42 days old.

3. Free-ranging fish populations found positive for IPNV may again be considered negative upon the completion of at least three consecutive negative inspections at least four (4) months apart over a period of at least 24 months.

D. Egg Disinfection

1. The operator and employees of any fish production facility must use the following procedures when disinfecting salmonid eggs received from any source:

a. Eggs shall be disinfected by soaking them in a solution containing one hundred parts per million iodine, in the form of povidone iodine, for a minimum of ten minutes before such eggs are allowed to come in contact with other eggs, fish, incubators, rearing spaces, or water supplies on a fish culture facility.

b. Hands, gloves, shipping containers and any implements or objects that contact such eggs before disinfection must not come into contact with other eggs, fish, incubators, rearing spaces, or water supplies on a fish culture facility until they have been disinfected using a commercially available disinfectant as directed on the product label.

UPSTREAM AQUATIC INSTITUTE

Addendum 2: The economic impacts of baitfish regulations in Colorado

January 2025

Victoria DeRooy & Amanda Hansen

Summary

In this report, we examine the economic effects of a ban on the import of live baitfish.

To provide the context that guides our analysis, we begin by highlighting the benefits that a baitfish import ban would bring for the general public in Colorado. A baitfish import ban would reduce the risk of fish establishing as invasive species in Colorado's lakes and rivers. A baitfish import ban would also reduce the risk of pathogens and parasites being transferred from baitfish to the native populations of fish living in Colorado's lakes and rivers. To put the benefits of this risk reduction in financial terms, the average cost incurred due to an aquatic invasion in the United States is $7.4 million. Any potential economic impacts ought to be understood in the context of this reduction in environmental and financial risk.

Then, we turn to how a baitfish import ban would be experienced by stakeholders in Colorado. We consider four key groups of stakeholders:

- Anglers. There are three lines of evidence that converge on the conclusion that recreational fishing will remain steady after a live bait import ban. Firstly, surveys of freshwater anglers in both Colorado and the United States reveal that very few anglers (around one percent) choose to use only live baitfish. Secondly, anglers overwhelmingly report that, if live bait regulations were implemented, they would continue fishing at the same rate. Thirdly, a separate statistical analysis was used to assess whether baitfish restrictions in the United States have had any effect on the public's engagement in fishing. The analysis showed that the public's engagement in fishing remains unaffected by these restrictions.
- Local businesses. Bait and tackle shop owners derive almost all of their revenue (96 percent) from sources other than live bait. The volumes of baitfish

sold are invariably low (averaging about 470 dozen per year). As such, we can be confident that the revenues of local businesses will remain unaffected by a baitfish import ban.

- Low-income communities. Live baitfish appears to be a luxury item, most frequently purchased and used by anglers with disposable income. In contrast, low-income anglers tend to use worms and/or source their own bait. This means that low-income anglers are unlikely to experience any disproportionate effects of a baitfish import ban.

On the basis of this data, we can be confident that a baitfish import ban would bring minimal economic risk to Coloradans. The reduction in risk, by preventing the establishment of invasive species and the spread of pathogens to Colorado's wildlife, would be far more significant in both environmental and economic terms.

1. Benefits for the general public

To provide context for our analysis, it is important to note the scale of the environmental and economic benefits that a baitfish import ban would bring to the general public in Colorado.

A baitfish import ban would bring two key benefits.

- Firstly, a baitfish import ban would significantly decrease the risk of new fish species establishing as invasive species in Colorado's lakes and rivers, which host exceptional biodiversity. Recent scientific studies have demonstrated that the transfer of live bait to new water bodies is a primary cause for the establishment of invasive fish species in the United States (*1*, *2*).
- Secondly, a baitfish import ban would reduce the risk of pathogens being transferred from baitfish to the native populations of fish living in Colorado's lakes and rivers. These pathogens include aquatic viruses, diseases (e.g., parasitic tapeworms), and invasive invertebrates (e.g., spiny water flea) (*1*). Additionally, live baitfish can carry invasive species, including silver carp, bighead carp, and Eurasian ruffe (*3*). Live baitfish can also harbor parasites. To illustrate, the Asian fish tapeworm was newly detected in the waters of New York State, and the evidence indicates that this tapeworm probably first entered New York's waters via the transport of baitfish between water bodies (*4*). Furthermore, studies have found that live bait sold in the Great Lakes region frequently contained pathogenic bacteria. This included bacteria known to cause disease in native fish (*5*).

A new aquatic invasive species would be costly. The most scientifically rigorous and up-to-date source that provides information on the financial costs of aquatic invasive species is the InvaCost database, which stores data on the costs of dealing with invasive species that have been published in scientific journals. The data contains information on the country and type of invasion (e.g. aquatic vs land), allowing us to obtain detailed information about specific invasion scenarios. The database contains 196 records of aquatic invasions that have occurred in the United States (*6*, *7*). On average, the cost incurred due to an aquatic invasion in the United States is $7.4 million (in 2024 terms) (*6*). These costs are incurred for many reasons, including: lost revenue from lower levels of public engagement with lakes and rivers; compromised ecosystem functions, such as fish production and water purification; and expenses faced by government departments when attempting to manage/eradicate the invasive species once that species has established. As such, by reducing the risk of introducing aquatic invasive species and spreading pathogens to Colorado's native wildlife, a baitfish import ban would help to save Colorado's taxpayers from incurring a cost from cleaning up a new invasive species—which averages $7.4 million for aquatic invasions in the United States.

Prevention is essential because once an invasive species is introduced to a lake or river, the damages are large and ongoing (*8*). After this point, managing the invasive species tends to be very costly. Where eradications have been attempted, the methods used for eradication are generally either costly and labor-intensive (e.g. large-scale, ongoing programmes using electrofishing or manual removal) or cause the lake's existing animal and plant populations to suffer damage that may persist for years (*9*, *10*). In either case, failures are common (*11*). This is the same conclusion drawn by Colorado's Aquatic Nuisance Species Management Plan (*12*). In contrast, a baitfish import ban is very cheap. We cannot know the costs of enforcement with certainty, but similar prevention programmes in other American lake and river systems (e.g. boat inspections) tend to cost close to 30,000 USD per year (*13*). This is purely illustrative, but it shows that it only takes a very minor investment to prevent a much larger cost in the near future.

2. Recreational fishing would remain steady

One key group of stakeholders who may be affected by a baitfish import ban are Colorado's anglers. We may want to know whether a baitfish import ban could impact the public's interest in recreational fishing. If so, this would have consequences for both the general public and the revenues that government departments earn from the sale of fishing licenses. Fortunately, we can have confidence that recreational fishing in Colorado would remain steady after live bait regulations.

This confidence is based on three convergent lines of evidence. Firstly, survey data shows that anglers are very flexible when choosing a bait type. Secondly, anglers consistently report that they would continue fishing at the same rate if faced with live bait regulations. Thirdly, a statistical analysis examining four states (including Colorado) reveals no evidence that live bait regulations affect the public's engagement in recreational fishing.

2.1 Anglers are flexible when choosing a bait type

Firstly, to provide up-to-date evidence on the attitudes of Americans towards potential baitfish import bans, Upstream Policies conducted a survey of anglers in Colorado in 2024 (see Addendum 3).

The survey included a number of questions on anglers' preferred types of bait, the sources of bait, type and frequency of fishing, and so on. The survey also included some demographic questions, such as the respondents' income brackets, to help us ensure that a baitfish import ban would not have a disproportionate impact on

low-income communities. We received responses to the survey from 611 anglers in Colorado.

Part of the survey focused on anglers' preferred type of bait. Only 13 percent of respondents reported using live baitfish as their first choice of bait (the same result as in the 2023 survey by Colorado Parks & Wildlife). Likewise, only a single respondent reported using live baitfish to the exclusion of all other types of bait. This suggests that the vast majority of anglers in Colorado either do not use live bait or are already comfortable using alternative bait.

2.2 Anglers would keep fishing at the same rate

Secondly, in that same survey of freshwater anglers, respondents were asked how they would respond to live bait regulations. The majority (52 percent) reported that they would continue fishing at the same rate. The percentages of respondents who reported that they would fish more often and less often were basically equal (21 and 19 percent, respectively). This suggests that, overall, recreational angling would remain steady after live bait regulations.

2.3 License data analysis reveals no effect of regulations on recreational fishing engagement

Thirdly, a state-level statistical analysis supports the notion that the public's engagement in fishing (and the revenues of regulatory agencies) is not affected by regulations restricting the use of baitfish.

We have attached a published scientific report that examines this question in detail (see Addendum 3) (*14*). The report looks at four American states that have implemented live bait restrictions (Colorado, Maine, New York, and Vermont) and conducts a statistical test to see whether live bait restrictions could have caused changes in the recreational licenses purchased by residents of those states.

Specifically, this analysis is a before-after, control-intervention, paired time series (BACIPS) analysis. The analysis uses time series data on the number of recreational fishing licenses purchased in a state in a particular year, compared to other states in the region. These time series are visualised below (for detailed statistical results, refer to the full report).

The analysis estimates the impact of an intervention (live bait regulations) on license sales, and examines both the immediate changes (e.g. a sudden rise or drop in license sales) and changes in the trend (e.g. if people start to buy more or fewer licenses over time). If a live bait ban causes people to become less interested in fishing, then that would show up in this analysis.

The analysis showed that live bait restrictions do not cause a decline in the public's participation in fishing. This provides a further line of evidence to support the conclusions drawn from the survey data (above). On the basis of this study, we can be confident that the public's engagement in fishing (and the revenues of regulatory agencies) are not affected by baitfish import bans.

It is worth noting that there is a background decrease in the public's participation in fishing in some states over time—however, the statistical analysis showed that this background decrease did not correspond to the timing of baitfish import bans in those states. The background decrease, which has been observed across the United States and even in other Western countries, is more likely due to other factors such as urbanisation and the availability of indoor recreational activities since the 1960s (*15*).

3. Local businesses do not depend on baitfish for revenue

Another key group of stakeholders are local businesses that may be involved in supplying or selling baitfish. In Colorado, the dependence of local businesses upon live bait for revenue appears to be very small.

According to 2023 USDA data, there was only one farm in Colorado producing baitfish (*16*). Our outreach to aquaculture operations in Colorado identified no farms that produce fish for use as live bait; it is likely that the farm recorded in the USDA data is for experimental or stocking purposes rather than for bait.

Bait and tackle shops are the largest group of local businesses involved in supplying bait to Colorado. These shops sell a variety of products, including different types of bait, fishing equipment, etc. Exact data is not available, but a good illustration comes from the federal government's survey of the American saltwater bait industry. This survey revealed that even for bait and tackle shops, only 2 percent of shops' revenues were derived from live bait. There are some other types of shops that sell bait, including hardware stores and sports good stores. However, given the much broader range of products sold by these shops, they have a negligible proportion of their revenue derived from this specific product (0.4 percent) (*17*).

This generally supports our own observations. When we have had the opportunity to ask bait and tackle shops about their sales volumes, we are invariably told that the volume of live bait sold is low—averaging about 470 dozen baitfish per store over the course of a year, corresponding to a sales revenue of roughly 2,000 USD per year[1]. It is reasonable to assume that much of this revenue would be replaced by alternative bait purchases.

[1]The 2,000 USD figure consists of 1,500 USD in wholesale value, allowing for a ~35% retail markup. The exact markup is unknown (*18*), but this gives a useful, indicative figure.

4. Limited impact on low-income communities

It is crucial that any environmental policy serves all Coloradans, rather than having a disproportionate impact on low-income communities.

Fortunately, we can be confident that a baitfish import ban would not have a disproportionate impact on low-income users of Colorado's waterways. In our survey, we asked respondents about their income category to ensure that we are informed about this specific topic. We separated the respondents by their income category to distinguish Americans in the lowest income category (annual income of $25,000 or less) from those in higher income categories.

Our survey revealed that live baitfish is a luxury item, most commonly purchased and used by people with larger amounts of disposable income. 11.1 percent of low-income respondents reported purchasing live baitfish. For wealthier people, that number rose to 13.7 percent. The proportion of live baitfish use differs between the two groups at the 0.05 significance level.

In contrast, it was more common for low-income respondents to use worms as bait (54 percent of low-income respondents *vs* 47% of higher-income respondents). A packet of 75 mealworms typically costs around $2, while the same number of live baitfish typically costs around $20[2].

This evidence provides confidence that a baitfish import ban would not disproportionately affect low-income Coloradoans.

[2] These prices are based on wholesale price lists for Delaware from January 2024.

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UPSTREAM AQUATIC INSTITUTE

Addendum 3: 2024 Survey of baitfish in recreational fishing in Colorado

January 2025

Victoria DeRooy & Amanda Hansen

Executive summary

An online survey was disseminated to anglers who had participated in recreational fishing in Colorado over the past three years. After quality control, the final number of responses was 611.

Key results regarding baitfish use are as follows:

- 13% of respondents expressed a preference for using live baitfish. This is identical to the prevalence of baitfish use in the most recent survey by Colorado Parks and Wildlife. A preference for live baitfish was more prevalent in wealthy respondents (13.7%) than low-income respondents (11.1%).
- 46% of respondents report having ever used live fish as bait in Colorado in the past three years (even if they prefer a different type of bait), while 54% report not having used live fish as bait. Of the respondents who have used live fish as bait, almost all (99.8%) report using at least one other type of bait (e.g. worms, artificial lures, dead whole fish or cut bait).
- Respondents most commonly report purchasing live fish from a store (90.4% reported "sometimes" or more) or collecting/catching the fish themselves (76.8%).
- Of respondents who collect fish for use as bait themselves, just under half of respondents report only ever using those fish on the body of water from which they originated (45.9%). A majority of respondents report using self-collected fish, at least occasionally, on different bodies of water (54.1%).
- When asked about leftover fish at the end of a fishing trip, around half of respondents reported keeping fish for future use. The remaining respondents report disposing of the leftover fish in the trash (35.8% for purchased fish; 28.2% for self-collected fish) or releasing the leftover fish in the water (18.1% for

purchased fish; 17.3% for self-collected fish). This may suggest that a sizable minority of anglers participate in the hazardous practice of releasing live bait fish in the water, and that some of these live fish may originate from other water bodies (including from stores).

Key results regarding policy support are as follows:

- When asked how they would respond if they could not purchase live fish for use as bait, respondents frequently stated that they would not change their fishing frequency (52%). Respondents faced with this scenario were approximately as likely to report an intention to fish more often (21.0%) than they were to report an intention to fish less often (18.7%).
- When asked about a proposed policy that would restrict imports of live fish for use as bait from outside Colorado into the state, respondents were more likely to support this proposal (46.2%) than oppose this proposal (24.2%), with a sizable minority being indifferent (31.6%).

Introduction

A statewide survey was conducted in October 2024 to gather data on Colorado anglers' behavior and attitudes relating to live fish used as bait. This survey aims to complement surveys previously conducted by Colorado Parks and Wildlife.

The key research questions posed are:

- How frequent is the use of live fish as bait by recreational anglers in Colorado?
- Where do anglers obtain live fish for use as bait?
- Where do anglers use live fish for use as bait, and what do they do with leftover fish?
- What are anglers' attitudes and stated behavioral responses to proposed policies relating to the use of live fish and bait?

Methods

Sampling frame and survey platform

The survey targeted recreational anglers in Colorado. Specifically, this was operationalised as "people who have participated in recreational fishing in Colorado in the past three years".

The survey was conducted on the online platform SurveyMonkey, using the SurveyMonkey Audiences feature. This platform delivered the survey to a preregistered survey audience with some predefined characteristics (i.e. Colorado residents with the hobby "fishing"). The first question in the survey checked eligibility by asking respondents whether they had participated in recreational fishing in the past three years, and the small number of respondents who answered "no" were disqualified. This enabled a large number of people in the sampling frame to be captured in an efficient and cost-effective manner.

Since their emergence over 20 years ago, online surveys have witnessed an increasing acceptance and uptake in scientific research and publications (Aguinis, Villamor, & Ramani, 2021; Evans & Mathur, 2018). Platforms frequently used in academic research include SurveyMonkey as well as MTurk, Prime Panels, Study Response, Qualtrics, Prolific Academic, and Sojump (Newman, Bavik, Mount, & Shao, 2021). Primary motivations are large participant pools, efficiency, and cost-effectiveness of data collection (Aguinis et al., 2021). However, every form of research method has its drawbacks, and online surveys are no exception; key risks include inattention and selection bias (Aguinis et al., 2021; Keith, Warshawsky, Neff, Loerzel, & Parchment, 2023). Inattention can be effectively alleviated through the use of attention check questions and attention metrics (e.g. response time), as was performed for this survey.

Bias, of course, remains a challenge. For the purposes of this survey, the question of bias relates not to whether the sample is representative of the country as a whole (in fact, SurveyMonkey Audience panels are designed to have a composition that roughly reflects the overall composition of the United States). Rather, the important consideration is whether the sample—people who have participated in recreational fishing in Colorado, are members of a SurveyMonkey Audience Panel, and opt in to this survey—are representative of the desired population—people who have participated in recreational fishing in Colorado. While those latter two characteristics of the sample (members of a SurveyMonkey Audience panel and opt in to this survey) inevitably introduce some amount of selection bias, this source of bias appears comparable to other online platforms (e.g. Qualtrics) and mail-in surveys (which are opt-in by definition). As such, while a truly random sample of Colorado's anglers would be ideal, it is reasonable to argue that the level of bias in this survey is comparable to that present in previous online and mail-in surveys conducted by Colorado Parks and Wildlife (Lischka, 2013; Platis & Schisler, 2021).

Sample size determination

The target sample size was determined with reference to the results from a previous US-wide survey. Recall that a key objective of the survey was to estimate the prevalence of the use of live fish as bait in Colorado. A previous US-wide survey (unpublished) on the use of live bait estimated that the probability of a respondent using live fish as bait was 0.48. This probability was utilized for the equation for determining a sample size, given an initial estimate of population prevalence (Naing, Nordin, Abdul Rahman, & Naing, 2022). Assuming $Z = 1.96$ and $d = 0.04$, this yielded a minimum sample size of n = 600.

Pilot sample

A pilot survey was conducted to ensure that the survey questions (including the attention check questions; see below) were functioning as intended and yielding high-quality responses. The pilot survey targeted 50 respondents, using the same sampling frame and survey platform as the full survey. Informal checks of these 50 responses determined that respondents generally answered most questions, that the response times were reasonable (median around 3 minutes), and the trends of responses were generally in line with those observed in previous surveys. No changes were made to the survey questions after the pilot sample; as such, the pilot sample is included as part of the full sample of respondents for formal data analysis.

Quality control

Given the online nature of the survey, it was deemed appropriate to conduct quality control. This was conducted following recommended best practices from the psychology literature. These recommendations include: conducting a pilot test to

ensure that the attention check question do not cause unintended consequences; using multiple attention check questions and only screening out responses that fail both tests; considering other metrics of inattentiveness, such as response time; and using questions that fit thematically within the survey (Ejelöv & Luke, 2020; Kay & Saucier, 2023; Muszyński, 2023). To avoid violating behavioral norms, it is also suggested to use innocuous attention check questions that may not even be perceived by the respondents to be attention checks (Muszyński, 2023). Many sources conclude that the most appropriate type of attention check question is an infrequency/frequency question, where a specific answer should be given by almost any attentive survey respondent (Kay & Saucier, 2023; Muszyński, 2023).

For this survey, a frequency question was obtained from the Comprehensive Infrequency/Frequency Item Repository (Kay & Saucier, 2023): "I like to spend my time doing things I enjoy." Respondents who selected "disagree" or "strongly disagree" were flagged as possibly inattentive. The second attention check question was a custom, innocuous attention check question, written by the authors to minimize interruption with the survey content: "In a typical fishing trip when you do use live fish for bait, do you keep the fish in water before you use them? (e.g. a bait bucket with some water in it)". Respondents who selected "no" were flagged as possibly inattentive. Note that the latter question was more likely to result in false positives, as it is possible that some anglers genuinely transport live fish for bait in a bucket without water.

Only three respondents failed both attention check questions. These three respondents had slightly shorter response times than other respondents, with a median of 2.45 minutes compared to the survey median of 3.07 minutes and a mean of 4.21 minutes compared to the survey mean of 15.1 minutes. As such, it was deemed valid to remove these three respondents prior to formal data analysis.

Results and Discussion

The achieved sample size, after accounting for quality control, was 611 responses. Note that some individual questions have lower numbers of responses due to survey skip logic and due to occasional incomplete responses.

The vast majority of respondents (95.5%) resided inside Colorado. The distribution of respondents by county approximately mirrored the overall population density of the state (Fig. 1).

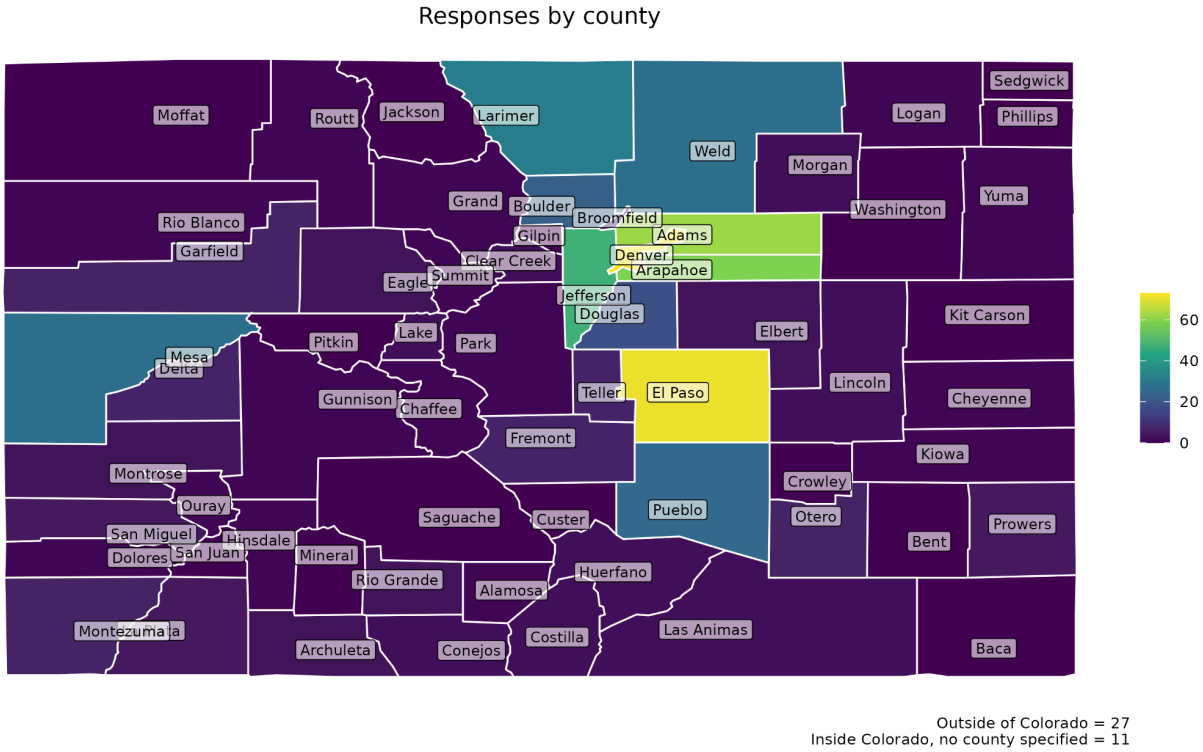

Fig 1. Map of survey responses by county

Live and non-live bait use

The percentage of respondents who use live baitfish as their preferred/first choice in Colorado was 13.4% (Fig. 2). This is almost identical to the prevalence that was estimated in the most recent angler survey conducted by Colorado Parks and Wildlife (2023, *pers. comm.*)

When disaggregating by income category, a preference for live baitfish was slightly more common in wealthy respondents (13.7% of respondents with annual income above 25,000 USD) than in low-income respondents (11.1% of respondents with annual income below 25,000 USD).

The percentage of respondents who report having used live fish as bait in Colorado at all over the past three years (including those who prefer to use a different bait type) was 46%, with the remaining 54% reporting not having participated in this practice.

Only a single respondent (0.2%) reports using live fish to the exclusion of all other types of bait. All other respondents who use live fish as bait also use at least one other type of bait (Fig. 3). Most common were worms (245 respondents), artificial lures and baits (150 respondents), and dead whole fish or cut bait (119 respondents). Respondents who selected "other" and elaborated further report using PowerBait, bread baits, homemade dough bait, clotted blood, gizzards, powerbait, eggs, and live grasshoppers.

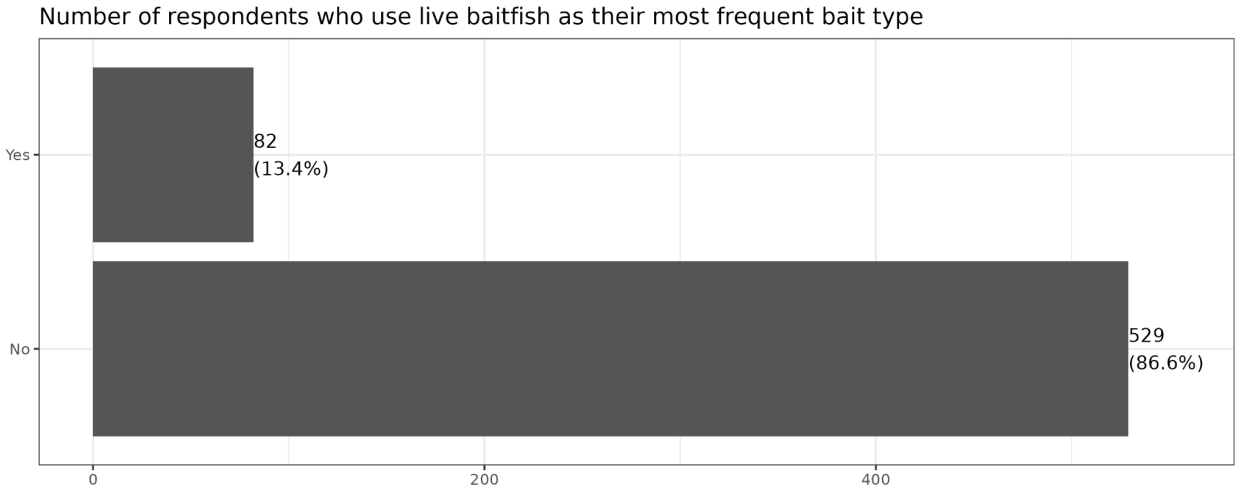

Fig 2. Live bait use

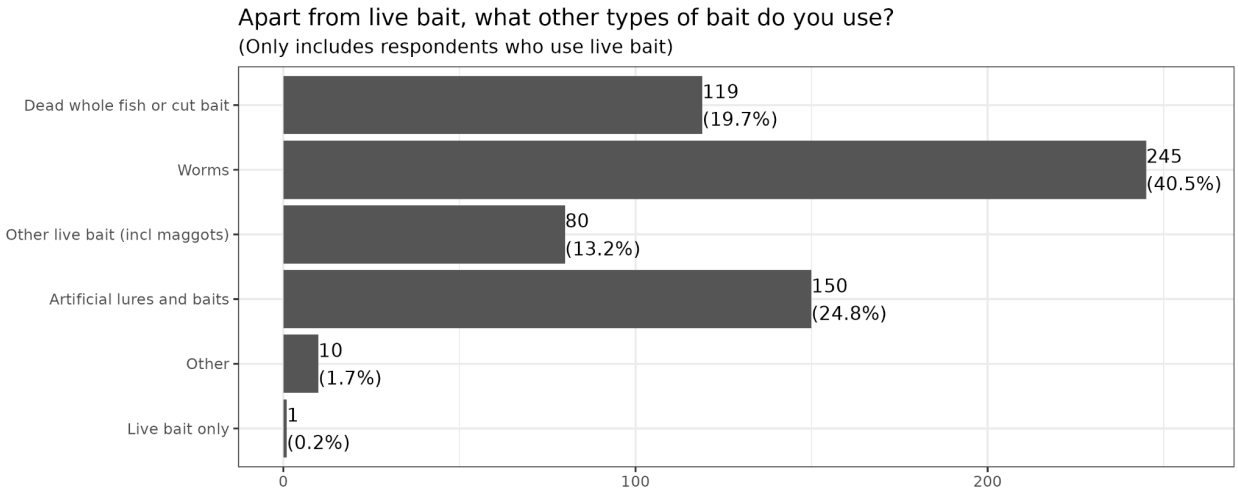

Fig 3. Non-live bait use by respondents who report using live bait.
(Note that respondents could select multiple items.)

Live bait fish behavior

Respondents who report using live fish for bait were asked how frequently they obtained those live fish from various sources (Fig. 4). It was common for respondents to report purchasing live fish from a store (90.4% reported "sometimes" or more; Fig. 4a) or collecting/catching the fish themselves (76.8% reported "sometimes" or more; Fig. 4b).

Respondents who collected/caught fish for use as bait themselves were asked about the bodies of water on which this occurs. Just under half of respondents (45.9%) report only ever using these self-collected fish on the same body of water from which they were obtained. The remaining respondents (54.1%) report using these self-collected fish, at least occasionally, on different bodies of water (Fig. 5).

Respondents were asked what they typically did with any leftover live bait fish at the end of a fishing trip (Fig. 6). Around half of respondents keep the fish for future use (45.6% for purchased fish; 53.5% for self-collected fish). The remaining respondents most frequently report disposing of the fish in the trash (35.8% for purchased fish; 28.2% for self-collected fish) or releasing the fish in the water (18.1% for purchased fish; 17.3% for self-collected fish).

This suggests that a sizable minority of anglers are participating in the hazardous behavior of releasing bait fish in water. This holds true even for respondents who purchase those fish from a store.

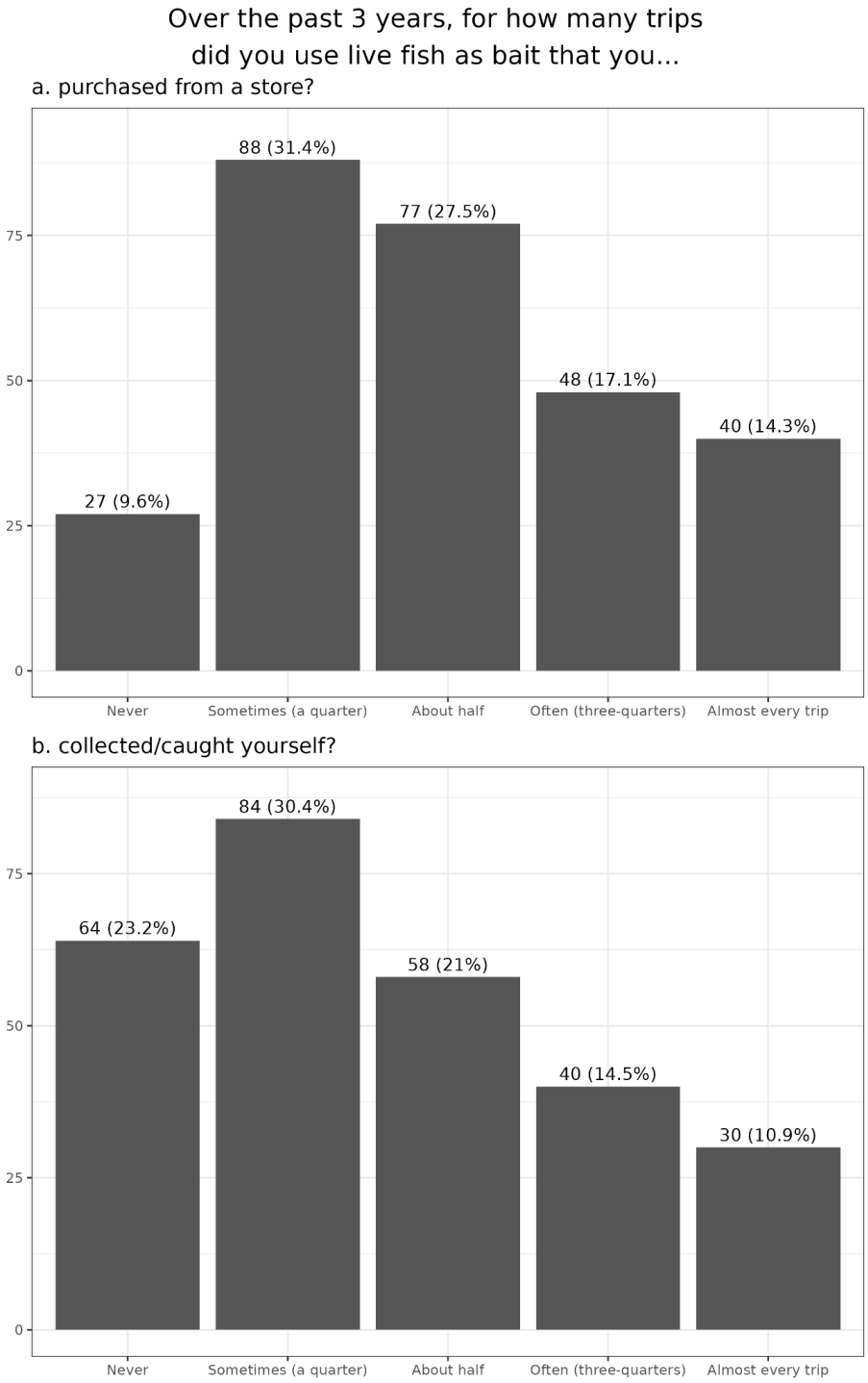

Fig 4. Sources of live fish used for bait

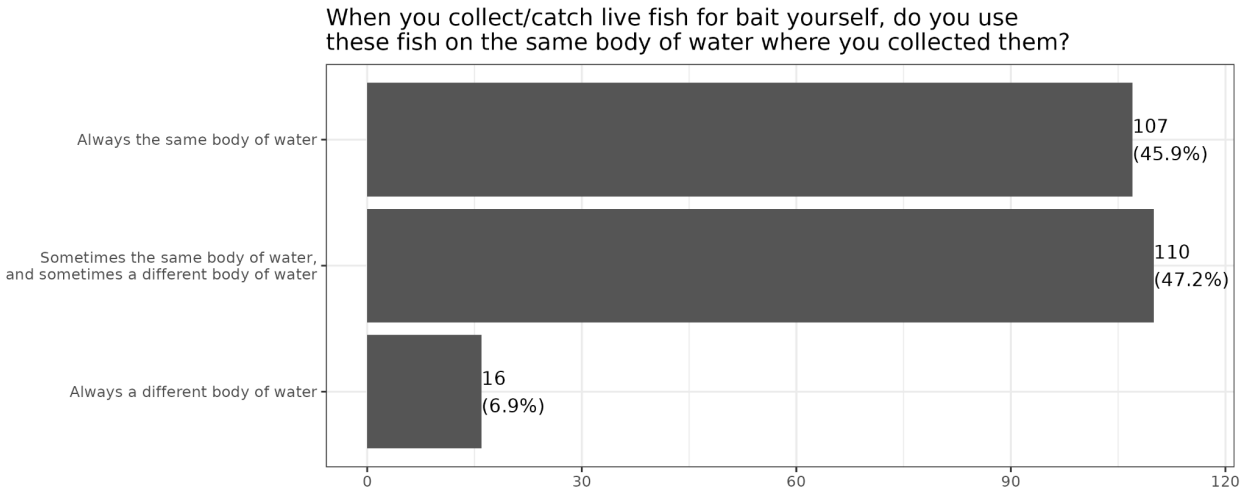

Fig 5. Water bodies where live fish are used for bait

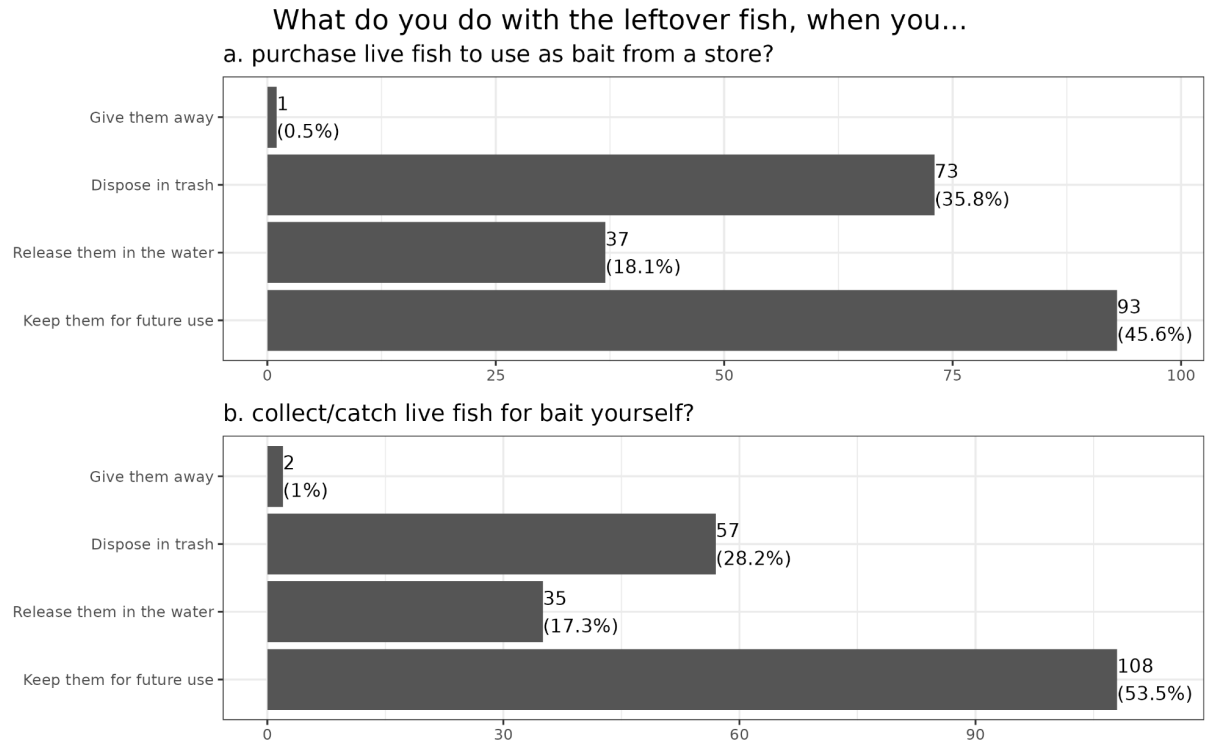

Fig 6. Disposal behavior of leftover live fish

Policy response

Respondents were asked about their behavioral response and attitudes to additional regulations on the use of live fish for bait.

Firstly, respondents were asked how they would respond, in terms of their fishing frequency, if they could not purchase live fish for bait (Fig. 7). The majority of respondents appeared indifferent, with 52% stating that they would not change their fishing frequency and 8.3% being unsure. The remaining respondents were approximately as likely to report an intention to fish more often (21.0%) than they were to report an intention to fish less often (18.7%).

Secondly, respondents were asked about their attitudes towards a specific proposed policy that would restrict imports of live fish for use as bait from outside Colorado into the state. To maintain neutrality and avoid biasing responses towards any particular outcome, the question was worded with reasons both for and against the proposed policy, as follows:

> Suppose a new law was being considered that would ban the importation of live fish from outside Colorado for use as live bait inside Colorado. Under this proposed law, anglers could continue to use live fish caught or farmed in the parts of Colorado where this is allowed.
>
> Supporters of this policy argue it would protect native fish species by reducing the risk of introducing aquatic invasive species and harmful pathogens.
>
> Opponents of this policy argue it could negatively affect local businesses that import live fish for bait from other states.
>
> Please rate your level of support for this proposed law.

Roughly one-third of respondents reported being indifferent towards this proposal (31.6%; Fig. 8). Just under one-half of respondents report either somewhat supporting or strongly supporting this proposal (46.2%). Just under one-quarter of respondents report either somewhat opposing or strongly opposing this proposal (24.2%).

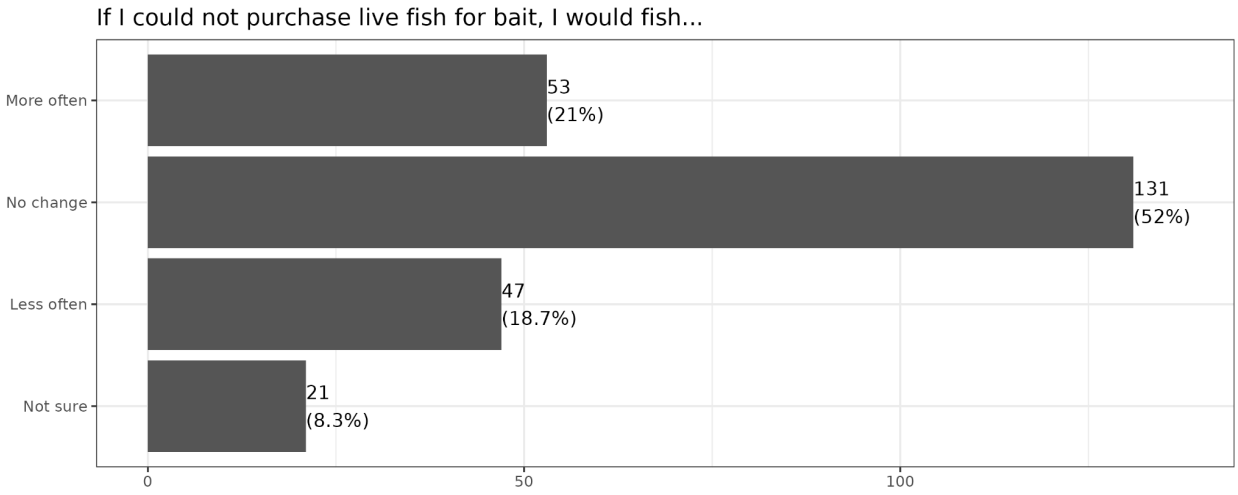

Fig 7. Stated behavioral response to restrictions on purchasing live fish

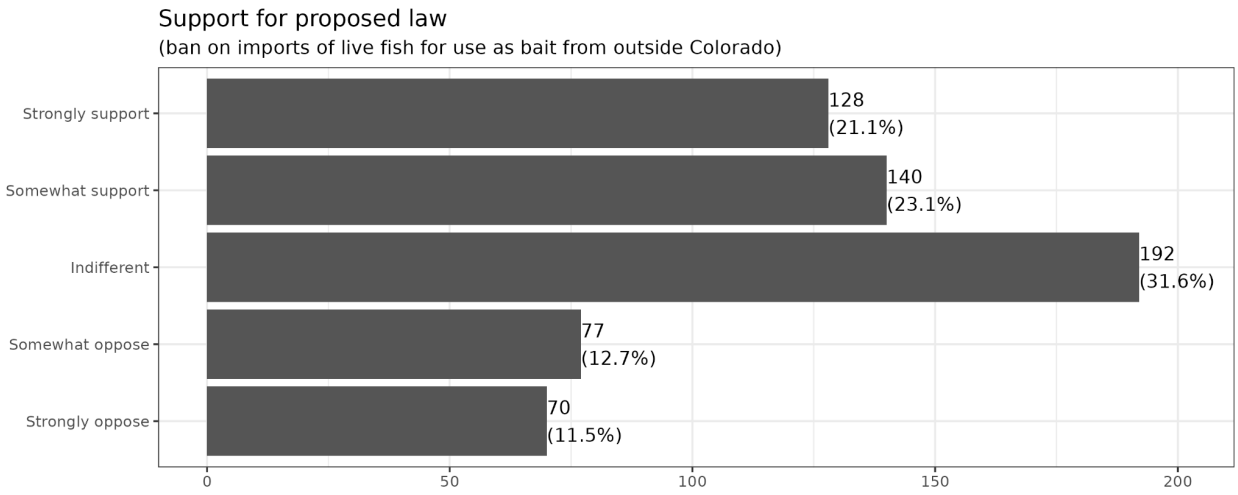

Fig 8. Stated attitude towards proposed restriction on imports of live fish from outside Colorado

Appendix

Data and code

The complete response data and replicable R code for analysis is available here.

Survey questions

1. Have you fished recreationally in Colorado in the last 3 years? Recreational fishing means fishing for pleasure, personal use, exercise, and/or competition.

- Yes
- No

2. What state do you reside in?

_____

3. What county do you reside in?

_____

4. What is your age?

- 18 to 24
- 25 to 34
- 35 to 44
- 45 to 54
- 55 to 64
- 65 to 74
- 75 or older

5. What is your approximate average household income?

- $0-$24,999
- $25,000-$49,999
- $50,000-$74,999
- $75,000-$99,999
- $100,000-$124,999
- $125,000-$149,999
- $150,000-$174,999
- $175,000-$199,999
- $200,000 and up

6. I like to spend my time doing things I enjoy.

- Strongly agree
- Agree
- Neither agree nor disagree

- Disagree
- Strongly disagree

The following questions ask about how you usually fish **in Colorado**.

7. In a typical year, how many fishing trips do you go on **in Colorado**? (If you don't know
exactly, a rough estimate is fine.)
_____

8. In the past 3 years, which fishing activities have you engaged in **in Colorado**? (Select all
that apply)
- Spinning, spin casting, or bait casting
- Fly Fishing
- Ice Fishing
- Other

9. In the past 3 years, have you used live fish as bait in Colorado?
- Yes
- No

10. You responded that you have used live fish as bait. In the past 3 years, which other types
of bait have you used for fishing in Colorado?
- Dead whole fish or cut bait
- Worms (lugworms, nightcrawlers, bloodworms)
- Other live bait (including maggots)
- Artificial lures or baits
- Other (please specify)

11. Think about your fishing trips in Colorado in the past 3 years.
- For how many trips did you use live fish as bait that you purchased from a store?
    - Never
    - Sometimes (about a quarter of my fishing trips)
    - About half of my fishing trips
    - Often (about three-quarters of my fishing trips)
    - Almost every fishing trip
- For how many trips did you use live fish as bait that you collected/caught yourself?
    - Never

    - Sometimes (about a quarter of my fishing trips)
    - About half of my fishing trips
    - Often (about three-quarters of my fishing trips)
    - Almost every fishing trip
- For how many trips did you not use any live fish as bait?
    - Never
    - Sometimes (about a quarter of my fishing trips)
    - About half of my fishing trips
    - Often (about three-quarters of my fishing trips)
    - Almost every fishing trip

12. In a typical fishing trip when you do use live fish for bait, how many live fish do you typically use as bait? (If you don't know exactly, a rough estimate is fine.)

_____

13. In a typical fishing trip when you do use live fish for bait, do you keep the fish in water
before you use them? (e.g. a bait bucket with some water in it)

- Yes
- No

14. When you purchase live fish from a store for use as bait, what do you usually do with the leftover fish?

- Give them away
- Dispose in trash or compost
- Release them in the water
- Keep them for future use
- I do not buy live fish from storest
- Other (please specify)

15. When you collect/catch live fish for bait yourself, do you use these fish on the same body
of water (e.g. river or lake) where you collected them?

- Always the same body of water
- Sometimes the same body of water, and sometimes a different body of water
- Always a different body of water
- I do not collect my own live fish for bait
- Other (please specify)

16. When you collect/catch live fish for bait yourself, what do you usually do with the leftover fish?

- Give them away

- Dispose in trash or compost
- Release them in the water
- Keep them for future use
- I do not collect my own live fish for bait
- Other (please specify)

17. If you could not purchase live fish for bait, what would you use for bait instead? (Select all
that apply)

- Collect/catch live fish myself
- Collect worms or another type of live bait myself
- Purchase worms or another type of live bait
- Purchase artificial lures or baits
- I do not purchase live fish for bait
- Other (please specify)

18. If you could not purchase live fish for bait, how would this affect the frequency of your fishing activities in Colorado?

- I would fish more often
- It would not change how often I fish
- I would fish less often
- Not sure
- I do not purchase live fish for bait

19. Think about your fishing trips in Colorado in the past 3 years.

- For how many trips did you use worms (lugworms, nightcrawlers, bloodworms)?
    - Never
    - Sometimes (about a quarter of my fishing trips)
    - About half of my fishing trips
    - Often (about three-quarters of my fishing trips)
    - Almost every fishing trip
- For how many trips did you use other live bait (including maggots)?
    - Never
    - Sometimes (about a quarter of my fishing trips)
    - About half of my fishing trips
    - Often (about three-quarters of my fishing trips)
    - Almost every fishing trip

20. In the past 3 years, if you have used live bait other than fish or worms when fishing in

Colorado, what do you usually use? (e.g. maggots, or something else - please provide details)

_____

21. In the past 3 years, have you used dead whole fish or cut bait when fishing in Colorado? If yes, where do you usually buy these from?

- Yes, and I usually buy them from a local store
- Yes, and I usually buy them from the internet
- No
- Other (please specify)

22. In the past 3 years, have you used artificial lures or baits when fishing in Colorado? If yes, where do you usually buy these from?

- Yes, and I usually buy them from a local store
- Yes, and I usually buy them from the internet
- No
- Other (please specify)

23. In the past 3 years, have you used worms (lugworms, nightcrawlers, bloodworms) when fishing in Colorado? If yes, where do you usually buy these from?

- Yes, and I usually buy them from a local store
- Yes, and I usually buy them from the internet
- No
- Other (please specify)

24. In the past 3 years, have you used other live bait (including maggots) when fishing in Colorado? If yes, where do you usually buy these from?

- Yes, and I usually buy them from a local store
- Yes, and I usually buy them from the internet
- No
- Other (please specify)

25. Suppose a new law was being considered that would **ban the importation of live fish**
from outside Colorado **for use as live bait inside Colorado**. Under this proposed law, anglers could continue to use live fish caught or farmed in the parts of Colorado where this is
allowed.

- **Supporters** of this policy argue it would protect native fish species by reducing the risk of introducing aquatic invasive species and harmful pathogens.

- **Opponents** of this policy argue it could negatively affect local businesses that import live fish for bait from other states.

Please rate your level of support for this proposed law.
Strongly oppose // Somewhat oppose // Indifferent // Somewhat support // Strongly support

26. Is there anything else you would like to add?
_____

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frontiers | Frontiers in Conservation Science

TYPE Brief Research Report
PUBLISHED 29 November 2024
DOI 10.3389/fcosc.2024.1446550

OPEN ACCESS

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RECEIVED 10 June 2024
ACCEPTED 15 November 2024
PUBLISHED 29 November 2024

CITATION
DeRooy V and Hansen A (2024) Untangling the impact of live baitfish restrictions on recreational fishing participation in the United States.
Front. Conserv. Sci. 5:1446550.
doi: 10.3389/fcosc.2024.1446550

Untangling the impact of live baitfish restrictions on recreational fishing participation in the United States

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In recent decades, many jurisdictions have established regulations governing the use of live baitfish in recreational fishing. Live baitfish can originate from either aquaculture farms or wild harvest. Live bait regulations are usually motivated by conservation concerns, such as the role that live baitfish play in the spread of invasive species and aquatic diseases. One barrier that may prevent policy regulation of live baitfish is the fear among policymakers that limiting the use of live baitfish could impact the general public's interest in fishing. However, conservation policy is hindered by the fact that there is very little research on this concern. In this study, we conduct a before-after control-intervention (BACI) analysis to test whether live baitfish regulations in the United States are followed by changes in recreational fishing. Using data from the 1960s to the present day, we analyze four states that have implemented live baitfish restrictions: Maine, New York, Vermont and Colorado. We find that live baitfish restrictions do not cause a decline in the public's participation in fishing. Our results can empower policymakers to craft evidence-based regulations on the use of live baitfish for conservation purposes while remaining confident that such policies are not likely to cause any unintended consequences on the recreational fishing community.

KEYWORDS

baitfish farming, fathead minnow, golden shiner, impact analysis, recreational fishing, fisheries management

Introduction

Recreational fishing is a popular pastime in countries all over the world. People may participate in recreational fishing for many reasons—people may want to catch their own food, to engage with nature, to socialize with other people, to experience a temporary escape, and to experience a sense of accomplishment, among other motivations (Arlinghaus et al., 2021). Since recreational fishing involves an economically, biologically, and socially important use of aquatic resources, recreational fishing has many implications for government policy (Scheufele and Pascoe, 2022).

One area of recreational fishing with important policy implications is the use of live baitfish. In North America, fishers may purchase live baitfish from retail stores, but fishers may also catch live baitfish themselves or use dead or artificial baits (Drake and Mandrak, 2014). The type of bait used may depend on the fisher's personal preference and the fishing context—for example, many game fishing tournaments prohibit the use of live bait, and live bait may pose a higher risk of gut hooking. The effects of live bait restrictions on recreational fishing are not immediately obvious. On one hand, a moderate proportion of recreational fishers appear to use live baitfish (e.g. 17% in a recent survey in Colorado, USA (Platis and Schisler, 2021); 55% in a recent survey in Ontario, Canada (Hunt et al., 2022)). On the other hand, these fishers use live baitfish as one bait type among many; it is rare for fishers to state that they use live baitfish exclusively (Hunt et al., 2022; Platis and Schisler, 2021).

In this study, we analyze the effects of live baitfish restrictions on recreational fishing. The past half-century has seen a number of statutes and regulations restricting the use of live baitfish. There are a number of states in the United States that have implemented restrictions on live baitfish (Kerr, 2012). Some examples of states with meaningful restrictions are Maine (Me. Stat. tit. 12, § 12461), New York (N.Y. Comp. Codes R. & Regs. tit. 6, pts. 10, 35, 188), Colorado (2 Colo. Code Regs. § 406-1-104) and Vermont (Vt. Code R. 12-010-088). The most common restriction is a prohibition on taking live baitfish and using those baitfish for fishing in a different waterbody—most states allow recreational fishers to catch live baitfish and then use those baitfish within the same body of water from which they were caught. Other states place bans on imports of live baitfish only (Kerr, 2012).

Restrictions tend to be motivated by environmental concerns. The transfer of live baitfish to new water bodies has been a primary cause for the establishment of invasive fish species in the United States (Kerr, 2012; McEachran et al., 2023). The risk of introducing invasive species is highest when baitfish is purchased live from retailers, as this causes baitfish to be farmed or caught in one water body and then used for fishing in a different water body. Fishers may empty bait buckets at the end of fishing trips, exacerbating the risk of introducing invasive species (Kerr, 2012). Recent studies have found that many retail stores in the United States sell live baitfish species known to be invasive (Mulligan et al., 2023; Snyder et al., 2020). Live baitfish may also cause the spread of aquatic viruses, diseases (e.g. parasitic tapeworms), and invasive invertebrates (e.g. spiny water flea) (Kerr, 2012). For example, one study found that the Asian fish tapeworm was widespread in live baitfish sold by retail stores in Michigan (Boonthai et al., 2017). Restrictions in the United States mirror developments in other jurisdictions, including many provinces in Canada and parts of Europe (Gunderson and Tucker, 2000; Kerr, 2012).

The United States is somewhat unique in having a small industry dedicated to producing farm-raised fish for use as live bait. The United States Department of Agriculture reports that, in 2022, there were 320 farms producing baitfish in the United States with a total value of 56 million USD (United States Department of Agriculture, 2024). Production tends to be clustered in a few large farms, with the most important states for the production of live baitfish being Arkansas, Ohio, Wisconsin, and Minnesota (United States Department of Agriculture, 2019).

Production volumes and prices have been declining over time (O'Dierno et al., 2003). The majority of costs experienced by farms are from labor, feed costs, marketing costs, and regulatory costs (Engle et al., 2020; van Senten and Engle, 2017). Many farms that produce baitfish are also involved in other industries, such as sportfish production (Van Senten et al., 2018). Baitfish are typically sold for between 4 and 10 USD per pound, depending on species, size, and time of year (Mcintosh, 2010). Baitfish can pass through multiple market stakeholders before finally reaching retail sale to customers for use in fishing (Mcintosh, 2010; O'Dierno et al., 2003). The most common species include fathead minnows (*Pimephales promelas*) and golden shiners (*Notemigonus crysoleucas*), plus a smaller number of fish from other species (McEachran et al., 2022; Mcintosh, 2010; United States Department of Agriculture, 2019). The industry focuses on freshwater baitfish for use in freshwater fishing, though some farms produce saltwater species for use in marine fishing.

A key question surrounding this policy debate is whether a restriction on live baitfish could impact the public's interest in recreational fishing (e.g. Copping, 2007). This question is relevant for three reasons. Firstly, states may place an intrinsic value on promoting fishing as a recreational activity. Secondly, state fisheries agencies often obtain revenue from the sale of fishing licenses. Thirdly, the number of fishing licenses sold in a state is used by the federal government to apportion, for that state, a particular share of the federal Wildlife and Sport Fish Restoration funding (Fish and Wildlife Service, 2024).

Therefore, it would be beneficial for state policymakers to know whether a ban on live baitfish could be expected to impact the public's interest in fishing. Despite the importance of this question, there has been basically no sophisticated analysis of whether live baitfish restrictions could impact the public's interest in fishing. A couple of studies have attempted to answer this question. One study concluded that there was no impact of baitfish regulations on license sales—however, this study was limited to Maine and was only able to use data up until 1991 (Frost and Trial, 1993). Another study concluded that the number of baitfish dealer licenses exhibited no statistical relationship with the number of anglers (Parker, 2021). This study was more recent, but it was also limited to Maine. This means that we are lacking information on most of the states that have implemented baitfish restrictions, especially since the turn of the century. In this paper, we address this knowledge gap by conducting a statistical analysis to untangle the effects of live baitfish restrictions on the public's interest in fishing.

Methods

Statistical modeling

How can we detect whether a live baitfish restriction affects interest in fishing? There are two possible effects of a live baitfish restriction. One possibility is that a live baitfish restriction could cause a sudden, discrete change in fishing. Another possibility is that a live baitfish restriction could cause a gradual change in fishing

over time—that is, a change in the *trend* of fishing. Furthermore, previous research has shown that the per-capita interest in fishing has decreased over time in many Western countries as other recreational activities have become available (Arlinghaus et al., 2021). This means that we need to detect any changes against this pre-existing background trajectory.

The statistical model that is appropriate is a before-after, control-intervention, paired series (BACIPS) model. A review of BACIPS models is given by Wauchope et al. (2021). Specifically, we use the model published as equation 4 in section S3 of that paper's Supplementary Material.

This model uses a time series of some outcome variable across two groups: an intervention group and a control group. The time series is separated into "before" and "after" the policy change that we are interested in. This way, we can measure whether the outcome variable responds to the policy change in a way that cannot be explained by background changes. We can also distinguish between immediate and longer-term effects of the policy change—the parameter $\beta[BA*CI]$ represents the immediate effect of the policy change, while the parameter $\beta[BA*CI*T]$ represents the effect of the policy change on the long-term trend. We conduct the analysis in the statistical programming software R (R Core Team, 2020), using the packages *ggplot2* (Wickham, 2016) and *sjPlot* (Lüdecke, 2021) to visualize our results.

In our case, we use annual data on fishing interest—the intervention group contains a state that has implemented a baitfish restriction in a particular year, and the control group contains the states in the surrounding region that did not implement such a ban. For example, if we want to examine the impacts of New York's live bait restriction in 2007 (Figure 1B), then our intervention group is New York; our control group is other states in the Northeast region of the United States; and our time series is separated into before 2007 and after 2007. In a minority of geographic locations, there are modest fluctuations in the historical license data. For example, fluctuations are visible around the year 1990 in Vermont (Figure 1C) and the West region (Figure 1D). The former may be attributable to demographic change, as there were no major management reforms relating to Vermont's recreational fishing licenses around 1990, but there was a sharp increase in urban population sizes in Vermont between 1980 and 1990 (U.S. Census Bureau, 2012; Vermont General Assembly, 2024). The latter may relate to a series of largely administrative changes in California license regulations in the late 1980s (California Department of Fish and Wildlife, 1999). Visual inspection reveals no meaningful differences in trends near the time of the live bait regulations studied here.

We conduct a separate statistical analysis on all four states that have implemented restrictions on the use or movement of live baitfish, as long as those restrictions were implemented within the date range of our data. These states are Maine (2007) (Figure 1A), New York (2007), Vermont (2007), and Colorado (2011). We

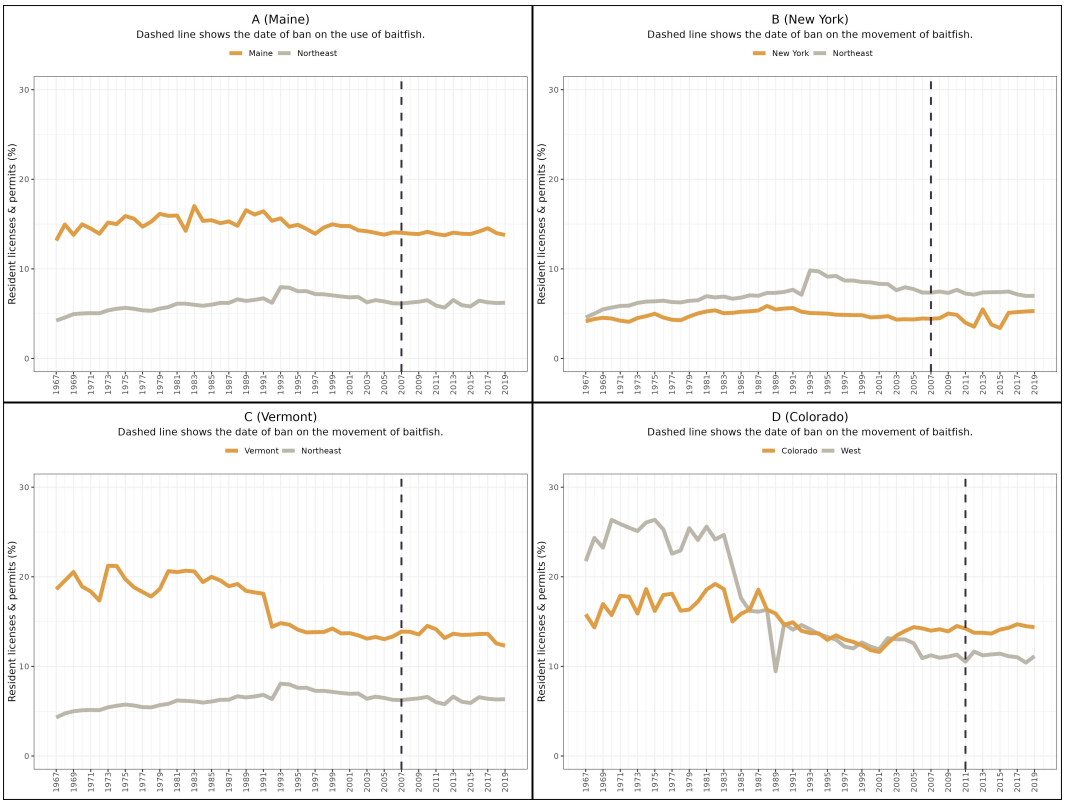

FIGURE 1
Trends in paid fishing licenses over time in four key states (**A**: Maine; **B**: New York; **C**: Vermont; **D**: Colorado) with restrictions on live baitfish (gold line) compared to other states in each region (gray line). Trends are expressed as a percent of the human population. Vertical dashed lines show the year in which a state's live baitfish regulation was established. Data: United States Fish and Wildlife Service (2024).

exclude states whose baitfish restrictions were implemented before the beginning of our dataset—Alaska (1960), Idaho (1947), Oregon (1940s), Minnesota (1927), Utah (1956), and Washington (1948). We also exclude the numerous states that have implemented import bans only, as an import ban would presumably have less impact on the day-to-day behavior of recreational anglers and would therefore be more difficult to detect statistically.

Data sources

As a measure for recreational fishing participation, we use data on the number of fishing licenses. Specifically, we obtained data on two variables:

- "Paid fishing license holders", which we use as a measure of the revenue that state fishing agencies obtain from fishers.
- "Resident fishing licenses, tags, permits and stamps", which we use as a measure of the general public's engagement in recreational fishing in a particular state.

Both variables are reported by state and year, with data from most states ranging from 1961 to 2021. The dataset is available for public download from the United States Fish and Wildlife Service via Amazon Quicksight (Fish and Wildlife Service, 2024). We inspected the data and removed a single outlier, which was clearly indicative of an administrative error (Vermont in 1970). Note that we express the data in terms of the year in which a license was issued, which is two years before the apportionment year (as expressed in the original dataset) (Fish and Wildlife Service, 2024).

The population of the United States has changed dramatically since the 1960s. To account for this, we express both of our variables as "per capita"—that is, divided by the number of people living in a particular state in a particular year. To convert our variables to per-capita, we obtained data on the United States human population. This dataset is made publicly available on Github by Tauberer (2020), which fetches and aggregates data on the annual population estimates originally estimated by the United States Census and published by the Federal Reserve Bank of St. Louis. This data gives annual estimates of the population of each state from 1900 to 2020.

We note that we do not correct for multiple comparisons. In the scientific community, opinions vary about whether or how to correct for multiple comparisons (Barnett et al., 2022; Greenland, 2021; Midway et al., 2020). For our analysis, we retain the standard significance threshold of 0.05—this allows us to decrease the risk that we fail to detect a real relationship, at the expense of increasing the risk that we "detect" a relationship that does not exist in reality. This is the most appropriate choice for our specific research question; if live baitfish restrictions indeed have an impact on the public's engagement in recreational fishing, this is a relationship that the relevant stakeholders for this analysis (i.e., policymakers) ought not to miss (Barnett et al., 2022; Greenland, 2021). To address the higher risk of false positives, we simply note any findings we detect that are on the threshold of statistical significance, as these are the findings for which correcting for multiple comparisons would cause us to draw different conclusions.

Results and discussion

Our analysis shows that live baitfish restrictions have no detectable impact on the public's engagement in recreational fishing (Table 1, Figure 2). This was true for both paid licenses and residential licenses and permits.

For paid licenses, every state's regression model showed no significant effect of the live baitfish restriction on the percentage of people who held paid licenses (compared to other states in that region) (Table 2). No state showed a meaningful change after the live baitfish restriction was implemented, whether immediately (table row $BAi \times CIj$) or in the long-term trend (table row $BAi \times CIj \times Ti$).

Likewise, for residential licenses/permits, every state's regression model showed no significant effect of the live baitfish restrictions on the percentage of people who held licenses (Table 3). Here too, no state showed a meaningful change after the live baitfish restriction was implemented, whether immediately (table row $BAi \times CIj$) or in the long-term trend (table row $BAi \times CIj \times Ti$). There are two possible exceptions. For New York, the regression model estimates that there was a 0.12% decrease in the number of residents who held licenses/permits after the baitfish regulations (table row $BAi \times CIj$). The model also estimates that this was followed by a 0.17% increase each year after the regulations (table row $BAi \times CIj \times Ti$). Likewise, for Vermont, the analysis estimates that the live baitfish regulations were associated with a 2.28% increase in the residential license/permit holders each year after the regulations (table row $BAi \times CIj \times Ti$). However, all three of these parameters had associated p-values that were very much on the threshold of significance ($p = 0.023$, 0.02, and 0.031 respectively). Had we corrected for multiple comparisons, these estimates would have been non-significant, indicating that these specific estimates may simply be a statistical artifact.

As such, the overall conclusion that can be drawn from our analysis is that live baitfish restrictions have no detectable impact on the public's engagement in recreational fishing. This lends credence to the findings of earlier state-specific studies, which also concluded that live baitfish regulations do not seem to impact the public's engagement in recreational fishing (Frost and Trial, 1993; Parker, 2021). This finding is reasonable given the trends in baitfish use typically observed in surveys of recreational anglers. While the proportion of fishers who use live baitfish is reasonably high (e.g.

TABLE 1 Key results from the statistical analysis.

State	Year and details of restriction	Effect on paid fishing licenses	Effect on resident fishing licenses
Maine	2007 (use ban)	No change	No change
New York	2007 (movement ban)	No change	No change
Vermont	2007 (movement ban)	No change	No change
Colorado	2011 (movement ban)	No change	No change

TABLE 2 Linear regression models for paid licenses.

	Maine				New York				Vermont				Colorado			
	β	*SE*	*t*	*p*	*β*	*SE*	*t*	*p*	*β*	*SE*	*t*	*p*	*β*	*SE*	*t*	*p*
(Intercept)	6.28	0.29	21.63	**<0.001**	6.98	0.19	37.18	**<0.001**	6.50	0.74	8.73	**<0.001**	9.42	0.49	19.42	**<0.001**
BAi	-1.05	0.67	-1.55	0.123	-1.29	0.44	-2.96	**0.004**	-1.07	1.73	-0.62	0.537	-1.27	1.43	-0.89	0.377
CIj	14.62	0.41	35.61	**<0.001**	-0.96	0.27	-3.60	**<0.001**	11.84	1.05	11.22	**<0.001**	5.62	0.69	8.19	**<0.001**
Ti	0.03	0.01	2.32	**0.022**	0.02	0.01	2.78	**0.006**	0.03	0.03	0.96	0.341	-0.15	0.02	-8.89	**<0.001**
BAi × CIj	0.62	0.95	0.65	0.516	0.71	0.62	1.15	0.255	3.46	2.45	1.41	0.160	-1.56	2.02	-0.77	0.443
BAi × Ti	-0.04	0.08	-0.52	0.602	0.00	0.05	0.06	0.949	-0.04	0.21	-0.19	0.848	0.15	0.27	0.55	0.583
CIj × Ti	-0.09	0.02	-5.38	**<0.001**	0.01	0.01	1.33	0.188	-0.34	0.04	-8.21	**<0.001**	-0.07	0.02	-2.88	**0.005**
(BAi × CIj) × Ti	0.17	0.12	1.46	0.148	-0.13	0.08	-1.67	0.098	0.16	0.30	0.54	0.591	0.42	0.38	1.11	0.272
Observations	114				114				113				114			
R^2/R^2 adjusted	0.987/0.986				0.583/0.555				0.939/0.934				0.894/0.887			

β denotes parameter estimate; *SE* denotes standard error; *t* denotes the t-value test statistic; *p* denotes p-value.
Bold text denotes statistical significance at the 0.05 significance level.

17% in Colorado, USA and 55% in Ontario, Canada), fishers overwhelmingly report using multiple bait types rather than live baitfish exclusively (Hunt et al., 2022; Platis and Schisler, 2021). It is possible that fishers faced with a new live bait restriction simply switch to other types of bait, which would explain the lack of an effect of restrictions on total recreational fishing activities as documented in this study.

Our results are subject to the usual caveats and limitations that apply to all studies like ours. The biggest caveat is that our data, like that of any similar policy study, is observational. Some disciplines such as medicine can use experimental trials to establish the effects of a particular policy on some relevant outcome variable (e.g. O'Donoughue Jenkins et al., 2016). However, in economics and resource policy, observational data from "natural experiments" are often the best available source of information (e.g. Eicher and Schreiber, 2010). We advise caution when attributing causation to any particular policy on the basis of data like ours. In fact, there is one reason that might confound our analysis—three of the four baitfish restrictions in our dataset were motivated by viral hemorrhagic septicemia (VHS). It is conceivable that public concern about VHS might have suppressed interest in recreational fishing independently of any effect on baitfish. However, if VHS does indeed confound our data, then it is likely to push our analysis towards detecting an effect of baitfish regulation—that is, public concern about VHS would cause false positives in our analysis. Thus, the fact that we did not detect any effect of baitfish restrictions on recreational fishing is unlikely to be confounded by the presence of VHS.

Another limitation with our study is that we assume that the best "control" group for a particular state contains all other states in the region of the United States (e.g. for New York, all other states in the Northeast). We maintain that this is the most appropriate choice, given the available data—indeed, this method has been applied in other studies on agricultural and resource economics

TABLE 3 Linear regression models for residential licenses and permits.

	Maine				New York				Vermont				Colorado			
	β	*SE*	*t*	*p*	*β*	*SE*	*t*	*p*	*β*	*SE*	*t*	*p*	*β*	*SE*	*t*	*p*
(Intercept)	7.29	0.20	36.67	**<0.001**	8.85	0.18	48.56	**<0.001**	7.40	0.33	22.51	**<0.001**	8.61	0.58	14.86	**<0.001**
BAi	-1.10	0.45	-2.47	**0.015**	-1.33	0.41	-3.25	**0.002**	-1.12	0.74	-1.51	0.133	3.03	1.64	1.85	0.068
CIj	7.43	0.28	26.45	**<0.001**	-3.92	0.26	-15.20	**<0.001**	5.71	0.47	12.23	**<0.001**	4.32	0.82	5.27	**<0.001**
Ti	0.06	0.01	6.61	**<0.001**	0.08	0.01	10.48	**<0.001**	0.06	0.01	4.06	**<0.001**	-0.41	0.02	-18.05	**<0.001**
BAi × CIj	0.29	0.63	0.46	0.646	0.64	0.58	1.10	0.273	2.28	1.04	2.19	**0.031**	-2.43	2.33	-1.04	0.300
BAi × Ti	-0.06	0.05	-1.07	0.289	-0.12	0.05	-2.31	**0.023**	-0.06	0.09	-0.64	0.526	0.30	0.31	0.99	0.322
CIj × Ti	-0.07	0.01	-5.72	**<0.001**	-0.08	0.01	-6.93	**<0.001**	-0.26	0.02	-12.94	**<0.001**	0.30	0.03	9.42	**<0.001**
(BAi × CIj) × Ti	0.08	0.08	1.09	0.278	0.17	0.07	2.37	**0.020**	0.14	0.13	1.13	0.261	-0.06	0.43	-0.14	0.886
Observations	106				106				105				106			
R^2/R^2 adjusted	0.980/0.978				0.852/0.841				0.964/0.962				0.817/0.804			

β denotes parameter estimate; *SE* denotes standard error; *t* denotes the t-value test statistic; *p* denotes p-value.
Bold text denotes statistical significance at the 0.05 significance level.

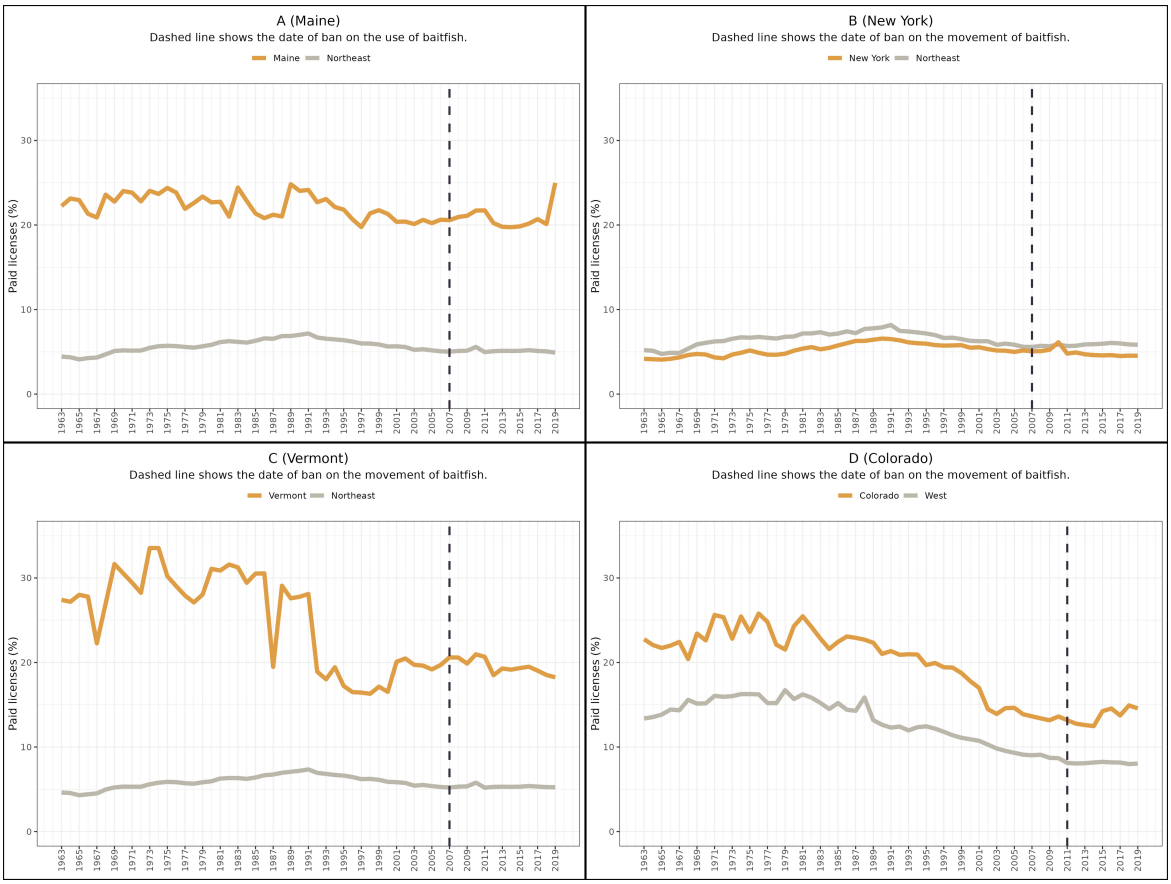

FIGURE 2
Trends in resident fishing licenses, permits, tags, and stamps over time in the four key states (**A**: Maine; **B**: New York; **C**: Vermont; **D**: Colorado) with restrictions on live baitfish (gold line) compared to other states in each region (gray line). Trends are expressed as a percent of the human population. Vertical dashed lines show the year in which a state's live baitfish regulation was established. Data: United States Fish and Wildlife Service (2024).

(Carter et al., 2021). However, we cannot rule out the possibility that there might be state-specific differences that are not accounted for by using nearby states as the control group.

Rigorous evidence can empower legislators and regulatory agencies to ensure that aquatic ecosystem management and policy is based on the best available science and a belief in the possibility of positive change (Esch et al., 2018; McAfee et al., 2019; Ryder et al., 2010). In this study, we have provided the best available evidence on the effects of live baitfish regulations on public engagement in fishing. We anticipate that the evidence and analysis provided in this study will empower policymakers to craft sound, evidence-based regulations on the use of live baitfish in the United States.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material. Further inquiries can be directed to the corresponding author.

Author contributions

VD: Conceptualization, Formal Analysis, Methodology, Writing – original draft, Writing – review & editing. AH: Conceptualization, Formal Analysis, Methodology, Writing – original draft, Writing – review & editing.

Funding

The author(s) declare that no financial support was received for the research, authorship, and/or publication of this article.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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