

# Recovery Implementation Strategy for Colorado Pikeminnow (*Ptychocheilus lucius*)



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U.S. Fish and Wildlife Service  
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## Introduction

This Recovery Implementation Strategy (RIS) supplements the Colorado pikeminnow recovery plan (Service 2023, entire). The recovery plan identifies 11 major management actions and assigns 2 general priorities to those actions. The RIS is the step-down, operational plan for the site-specific management actions described in the recovery plan. This RIS:

1. Identifies activities needed to implement the actions in the recovery plan;
2. Identifies more detailed activities that need to be implemented rangewide and for each subbasin population (Green River, San Juan, upper Colorado River, and Lower Colorado River Basin); and
3. Provides estimates of the frequency with which subbasin activities should occur.

The activities, detailed subbasin activities, and timeframes in the RIS may be revised at any time during the recovery process based on experience, new scientific information, identification of new threats, or refined identification of species needs. Changes in the 11 recovery actions and their associated general priorities can only be made by formally modifying the recovery plan, which would require public notice and comment. However, we note that a recovery plan is not a regulatory document and provides recommendations on actions needed to achieve the recovery vision.

In this RIS, “actions” are the site-specific management actions from the recovery plan that describe what needs to be done to accomplish the recovery vision. “Activities” in the RIS are the even more detailed, subbasin-specific measures needed to implement the actions from the recovery plan. Potential activity partners include a variety of partners who may engage in implementing activities to varying degrees, from providing supporting information or tools to implementation. Because this may vary by activity type, subbasin, and population and duration of an activity, we have not identified any activity partners in implementing any given activity.

As stated in the recovery plan, there are still uncertainties in the level of action and the species’ response to actions, so research needs to be conducted to refine the needs of Colorado pikeminnow in each subbasin. The best available science from this research should be used to guide and implement recovery actions and management practices. In addition, recovery actions should be periodically evaluated and revised based on the response of Colorado pikeminnow populations (Service 2022, pp. 16–17). This uncertainty and research need also applies to the recovery activities in the RIS.

The Upper Colorado River Endangered Fish Recovery Program and the San Juan River Basin Recovery Implementation Program will identify specific subbasin activities, priorities, time frames for implementation of those specific activities, and responsible activity partners to implement those activities at the subbasin level. These specific subbasin activities will be incorporated into long range plans for each of the two recovery programs. Based on priorities established by the programs, activities will be incorporated into the recovery programs’ annual budgets, funded, and implemented. The priorities established for implementation of subbasin recovery activities may differ from the general priorities (1 and 2) listed in the RIS. Subbasin activities and priorities established by the programs may change periodically based on the need to respond to new scientific information regarding species needs, threats to the species, and/or

effectiveness of activities in each subbasin. Given the need for the programs to identify subbasin activities and priorities and that those activities and priorities may change frequently, the RIS does not identify priorities for the more detailed subbasin activities.

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## Recovery Actions and Activities

In this section we identify the recovery activities associated with the 11 recovery actions from the recovery plan for Colorado pikeminnow. We list activities to be implemented rangewide and in each subbasin. Per the recovery plan, Priority 1 actions and activities are defined as those that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future. Priority 2 actions and activities are those that remove, reduce, or mitigate major threats or fill knowledge gaps and lessen or prevent continued population or habitat quality decline or some other significant negative impact. The assignment of priorities does not imply that some actions and activities are of low importance, rather it implies that Priority 2 items may be deferred while Priority 1 items are being implemented and they may differ among populations. The numbering scheme used to list the priorities and activities is not intended to serve as a ranking. Please refer to Table 1 for a clear association among recovery actions, activities, and threats they address. Priorities for implementation of subbasin recovery actions and activities by the Upper Colorado and San Juan recovery programs will vary among subbasins and will depend on species needs and threats in each subbasin.

### Priority 1 Actions and Activities Defined

The recovery plan identifies 11 recovery actions, which are repeated here (paragraphs 1 through 11), with the associated list of recovery activities (1.1, 1.2, 2.1 etc.) for each recovery action:

1. Manage river flows in all subbasins to include both inter- and intra-annual variability that approximates the natural hydrograph and supports Colorado pikeminnow life history. This action provides an ecologically based suite of flows throughout the year and between years. For example, spring peak flows should clean spawning substrates, maintain channel complexity, create nursery habitats, provide access to floodplains, and promote movements to spawning areas. Base flows should support fish movement, maintain food web productivity, transport larvae, and maintain nursery habitats.
  - 1.1. Provide spring peak flows and strive to meet recommendations based on most recent information and analysis
  - 1.2. Provide base flows where applicable and strive to meet flow recommendations
  - 1.3. Evaluate flow recommendations periodically as new information becomes available to assess whether they are meeting intended outcomes and achieving/supporting recovery. Revise flow recommendations as needed
  - 1.4. Implement flow recommendation targets according to their prescribed frequencies
  - 1.5. Identify and acquire additional sources of water to manage flows
  - 1.6. Protect flow releases downstream to meet flow recommendations
  - 1.7. Manage flows in tributaries to allow seasonal access (e.g., spawning) by Colorado pikeminnow, where possible and appropriate
  - 1.8. Implement drought response plans in a manner to support and enhance habitat for Colorado pikeminnow
2. Operate and maintain fish passage facilities in all subbasins to facilitate Colorado pikeminnow movement. This action provides habitat access across the species' current range that allows for use suitable to fulfill life history requirements.
  - 2.1. Maintain and operate existing fish passage facilities on diversions

- 2.2. Manage flows to extend duration of passage operations and to allow access to passages
  - 2.3. Provide adequate flows and maintain facility operations as much as possible during the time period(s) in which Colorado pikeminnow require passage to fulfill life history requirements
  - 2.4. Study effectiveness of passages to determine actual fish use and improve where needed
  - 2.5. Minimize native fish entrainment into water infrastructure at diversions
  - 2.6. Construct, maintain, and operate facilities that reduce Colorado pikeminnow entrainment into water delivery systems
  - 2.7. Investigate alternative devices and technology to minimize entrainment
  - 2.8. Improve entrainment prevention facilities, if needed
3. Control nonnative fish populations that reduce Colorado pikeminnow abundance and survival, particularly in the Colorado and Green river subbasins. This action improves Colorado pikeminnow recruitment and survival by reducing predation and competition from problematic nonnative species. Successful implementation of this action will minimally involve determining the level of invasive species reductions needed to improve Colorado pikeminnow demographics, developing new strategies and methods, and implementing additional or novel methods to suppress or eradicate nonnative fishes at a landscape scale.
    - 3.1. Remove smallmouth bass and implement strategies to reduce reproductive success (e.g., seasonal flow spikes)
    - 3.2. Remove walleye, especially in lower river reaches of Colorado and Green rivers
    - 3.3. Remove northern pike, especially in the Yampa River basin and implement strategies to disrupt spawning
    - 3.4. Measure effects of control programs on the abundance, distribution, and reproductive success of target nonnative species
    - 3.5. Refine estimates of problematic nonnative fish species abundance reduction required to produce positive native fish response
    - 3.6. Determine threat posed to Colorado pikeminnow by nonnative fish species in the San Juan River
    - 3.7. Implement control of nonnative fishes in the San Juan River basin commensurate with the threat, as determined above
    - 3.8. Develop additional or novel methods to suppress nonnative fishes at a landscape scale or at critical times in their life history in specific locations
    - 3.9. Control escapement of non-native species from reservoirs through implementation, operation, and maintenance of fish screens on reservoir outlet works
    - 3.10. Investigate the use of flow management to disadvantage nonnative fishes of concern
    - 3.11. Investigate use of YY fish (Trojan Y chromosome) technology and emerging genetic and other biocontrol technologies to reduce invasive fish populations and implement if proven effective
    - 3.12. Research additional mechanical and chemical methods of control
    - 3.13. Determine optimal timing/conditions for control strategies
    - 3.14. Support angler harvest of nonnative fish species with fishing tournaments, bounties or other activities as appropriate
    - 3.15. Using monitoring data, identify the presence of any new non-native species, the threat to listed species posed by those nonnative species, the source, and implement control measures as needed

4. Develop captive broodstock(s) from wild fish to maintain existing genetic diversity of populations in the Colorado and Green river subbasins. This action protects the extant genetic and life history lineages. Broodstock(s) should serve as a genetic refuge and provide offspring for augmentation programs where needed. If determined necessary to meet demographic recovery criteria, this action should include production, rearing, and stocking sufficient numbers of Colorado pikeminnow to meet stocking goals and implement augmentation plans.
  - 4.1. Collect wild fish to create or augment existing broodstock
  - 4.2. Determine genetic makeup of collected fish
  - 4.3. Develop genetics management plan for producing fish that maintains the same genetic diversity as wild populations
  - 4.4. Construct new facilities for Colorado pikeminnow production to ensure genetic integrity and redundancy, as needed
  - 4.5. Operate and maintain facilities for propagation
  - 4.6. Determine need for augmentation in the Colorado and Green River subbasins and develop augmentation plans (sizes, numbers, locations) as needed. If appropriate, consider combining augmentation plans into an Upper Basin strategy to include the San Juan River
  - 4.7. Continue augmenting Colorado pikeminnow in the San Juan River subbasin
  - 4.8. Evaluate stocking programs' progress in supporting recovery and maintaining genetic diversity and revise plans based on findings
  - 4.9. Improve hatchery rearing methods to increase survival and success of future reintroductions

## Priority 2 Actions and Activities Defined

5. Conserve, or improve, native fish communities to provide a forage base for all life stages of Colorado pikeminnow in all subbasins. This action supports growth and survival of Colorado pikeminnow. Supporting native fish communities may include controlling nonnative fish to reduce impacts to native fish species and augmenting or reintroducing native fish species where necessary, in addition to implementing flow management described for Colorado pikeminnow.
  - 5.1. Reintroduce or augment native fish populations to restore fish communities
  - 5.2. Monitor native fish communities to determine response to management actions
  - 5.3. Operate fish passages and fish screens to the benefit of the native fish communities.
6. Create and maintain habitats for Colorado pikeminnow using mechanical restoration methods or flow management actions in all subbasins. This action provides necessary habitats through a variety of mechanisms, including if climate change causes natural hydrologic conditions to become insufficient to perform habitat maintenance functions. Flow management activities under this action might differ from those intended to directly benefit Colorado pikeminnow populations, such as flows to reverse negative effects of vegetative encroachment or to transport sediment.

- 6.1. Use flow management from reservoirs for habitat maintenance (may be different than activities listed in flow recommendations)
  - 6.2. Investigate methods to provide and maintain habitats (e.g., woody debris, cobble bar enhancement, removal of invasive channel-encroaching vegetation, etc.)
  - 6.3. Assess the technical feasibility and cost of using mechanical restoration to produce habitat to achieve recovery criteria in the San Juan subbasin
  - 6.4. Construct secondary/low velocity habitats, including functional riparian/floodplain areas, and increase/maintain channel complexity via mechanical methods
  - 6.5. Develop and implement adaptive management plans to monitor habitat, determine response to management actions, and adjust habitat management actions as needed to maximize success
7. Develop partnerships to improve land management practices that may reduce water quality via runoff of contaminants or spills in all subbasins. This action protects stream water quality. The recommended actions below are intended to be implemented in the order presented.
    - 7.1. Identify potential sources of contaminants, assess risk to Colorado pikeminnow, and develop water quality improvement plans to implement actions that will reduce risks
    - 7.2. Determine effects of contaminants on Colorado pikeminnow population dynamics
    - 7.3. Develop partnerships to address upland sources of contaminants, pollutants, and/or increased erosion that could run off into river habitats
    - 7.4. Work with state pollution control agencies to establish water quality standards for pollutants that are protective of all Colorado pikeminnow life stages
    - 7.5. Coordinate with reservoir operators to manage sediment releases during dam maintenance operations
8. Operate dams to provide appropriate release water temperatures to meet life history requirements, specifically from Flaming Gorge Dam, Navajo Dam, and the Aspinall Unit. This action should be continued at Flaming Gorge Dam or enacted where feasible at the other locations if water temperatures are a limitation in achieving demographic recovery criteria.
    - 8.1. Continue operating Flaming Gorge Selective Withdrawal Structure to meet temperature recommendations from Muth *et al.* 2000 and LaGory *et al.* 2019
    - 8.2. Investigate potential for upstream expansion of Colorado pikeminnow as temperatures warm
    - 8.3. Determine costs and demographic benefits to Colorado pikeminnow of temperature modifications at additional facilities (e.g., Navajo Dam, dams in the Aspinall Unit)
    - 8.4. Evaluate the consequences of projects to warm the river (e.g. nonnative species range expansion)
9. Expand Colorado pikeminnow access into the greatest feasible extent of historically occupied range. This action increases the species' resiliency, redundancy, and representation, recognizing that Colorado pikeminnow is currently limited to a small portion of its former range. Implementation of this action might include exploring opportunities to reintroduce the species, constructing additional passage or improvement projects, or modifying existing structures where access is a limitation to achieving demographic recovery criteria. Warmer



stream temperatures from climate change and future management actions could lead to improved habitats outside the current distribution for Colorado pikeminnow. Periodic assessments should be conducted to determine the suitability of additional reaches to contribute to recovery of the species, particularly in the Lower Colorado River Basin.

- 9.1. Identify barriers to movement within current distribution
  - 9.2. Develop priority list for passage projects
  - 9.3. Investigate potential to reintroduce Colorado pikeminnow into historically occupied reaches. This activity becomes more important if recovery criteria are not being met
  - 9.4. Assess potential for reintroductions based on current and predicted future changes in river conditions and management
  - 9.5. Evaluate the potential consequences (e.g., range expansion of nonnative species) of any range expansion project
10. Prevent escapement of invasive fishes from source populations by constructing exclusion facilities, replacing invasive species in reservoirs with compatible sport fisheries, and eliminating sources where possible. This action reduces threats posed by the expansion of nonnative species into the current range of Colorado pikeminnow.
- 10.1. Operate and maintain existing exclusion facilities including screens, nets, and other containment facilities
  - 10.2. Evaluate the need for additional reservoir containment solutions and construct where needed
  - 10.3. Use chemical renovations to remove problematic nonnative fish as needed
  - 10.4. Monitor effectiveness of containment facilities and eradication efforts
  - 10.5. Monitor for invasions of nonnative fishes in tributaries and mount rapid response to prevent establishment
  - 10.6. Evaluate risks of nonnative fish escapement due to low reservoir elevations or reservoir flow management practices (e.g., spills, maintenance)
  - 10.7. Identify, control, and/or prevent escapement from off channel sources of nonnative fish species including gravel pits and connected ponds
11. Reduce illicit and unintentional movements of all invasive taxa that could become established in Colorado pikeminnow current range by conducting outreach, enacting regulations where needed, and enforcing regulations. This action reduces the risks posed by the introduction or establishment of additional invasive species.
- 11.1. Conduct outreach to prevent illicit introduction and unintentional movements of invasive species
  - 11.2. Identify potential sources and risks of novel introductions (e.g., nearby basins)
  - 11.3. Evaluate impacts of other invasive species on Colorado pikeminnow habitats and populations (e.g., crayfish, plants, mussels)
  - 11.4. Continue enforcement of applicable laws and regulations to address movement of invasive species
  - 11.5. Develop and implement a suite of suggested regulatory/enforcement approaches to address illicit fish introduction

Table 1. Factors affecting the survival of Colorado pikeminnow (U.S. Fish and Wildlife Service 2020, pp. 16–18) and associated recovery actions and criteria (Service 2023, pp. 11–19).

<b>Listing Factors under the Act</b>	<b>Threats Description</b>	<b>Recovery Actions</b>	<b>Recovery Criteria</b>
Factor A- <i>The present or threatened destruction, modification, or curtailment of its habitat or range</i>	Habitat degradation and fragmentation due to water development, invasive vegetation, and land uses	1, 2, 6, 8, 9	I, II, III, IV, V, VI
Factor C- <i>Disease or predation</i>	Predation	3, 10 ,11	III, IV, V
Factor E- <i>Other natural or manmade factors affecting its continued existence</i>	Small population size and extirpation in some basins	4	I, II
	Climate change	1, 2, 6, 8	V, VI
	Contaminants	7	II, III, IV
	Reduced forage base	5	II, V, VI

## Rangewide Activities

Many recovery activities involve participants and stakeholders from all subbasins across the range of Colorado pikeminnow, as listed below. These are activities that can be implemented most efficiently as a group or in a conference setting, not necessarily activities that are on the ground efforts that also occur in every subbasin. In some cases, the activity may be listed here as well as in specific subbasins if there is already an identified need for that activity specifically in that subbasin. It is anticipated that rangewide and subbasin activities identified below will be implemented for 15 years, consistent with the recovery plan. However, these activities may be terminated or modified as needed during the 15-year period.

Activity Number	Activity Description	Activity Frequency (years)
<i>Action 1</i>	<i>Manage river flows in all subbasins to include both inter- and intra-annual variability that approximates the natural hydrograph and supports Colorado pikeminnow life history. This action provides an ecologically based suite of flows throughout the year and between years. For example, spring peak flows should clean spawning substrates, maintain channel complexity, create nursery habitats, provide access to floodplains, and promote movements to spawning areas. Base flows should support fish movement, maintain food web productivity, transport larvae, and maintain nursery habitats.</i>	
1.1	Provide spring peak flows and strive to meet recommendations based on most recent information and analysis (Flaming Gorge, Aspinall, Navajo, Duchesne, White, 15-Mile Reach)	ongoing but site-specific
1.2	Provide base flows where applicable and strive to meet flow recommendations (Flaming Gorge, Aspinall, Navajo, Duchesne, White, Yampa, 15-Mile Reach)	ongoing but site-specific
1.3	Evaluate flow recommendations periodically as new information becomes available to assess whether they are meeting intended outcomes and achieving/supporting recovery. Revise flow recommendations as needed	ongoing, but basin-specific
1.4	Implement flow recommendation targets according to their prescribed frequencies	ongoing
1.5	Identify and acquire additional sources of water to manage flows	ongoing, as opportunities arise
1.6	Protect flow releases downstream to meet flow recommendations	ongoing
1.7	Manage flows in tributaries to allow seasonal access, where possible and appropriate	ongoing but site-specific
1.8	Implement drought response plans in a manner to support and enhance habitat for Colorado pikeminnow	ongoing but site-specific

<b>Activity Number</b>	<b>Activity Description</b>	<b>Activity Frequency (years)</b>
<i>Action 2</i>	<i>Operate and maintain fish passage facilities in all subbasins to facilitate Colorado pikeminnow movement. This action provides habitat access across the species' current range that allows for use suitable to fulfill life history requirements.</i>	
2.1	Maintain and operate existing fish passage facilities on diversions	ongoing
2.4	Study effectiveness of passages to determine actual fish use and improve where needed	every 3–5 years
2.5	Minimize native fish entrainment into water infrastructure at diversions	ongoing
2.6	Construct, maintain, and operate facilities that reduce Colorado pikeminnow entrainment into water delivery systems	ongoing
<i>Action 3</i>	<i>Control nonnative fish populations that reduce Colorado pikeminnow abundance and survival, particularly in the Colorado and Green River subbasins. This action improves Colorado pikeminnow recruitment and survival by reducing predation and competition from problematic nonnative species. Successful implementation of this action will minimally involve determining the level of invasive species reductions needed to improve Colorado pikeminnow demographics, developing new strategies and methods, and implementing additional or novel methods to suppress or eradicate nonnative fishes at a landscape scale.</i>	
3.4	Measure effects of control programs on the abundance, distribution, and reproductive success of target species	ongoing, periodic
3.5	Refine estimates of problematic nonnative fish species abundance reduction required to produce positive native fish response	2-4 years per nonnative fish species
3.8	Develop additional or novel methods to suppress nonnative fishes at a landscape scale or at critical times in their life history in specific locations	4–5 years
3.9	Control escapement of non-native species from reservoirs through implementation, operation, and maintenance of fish screens on reservoir outlet works	ongoing
3.10	Investigate the use of flow management to disadvantage nonnative fishes of concern.	5 years
3.11	Investigate use of male YY technology and emerging genetic and other biocontrol technologies to reduce invasive fish populations and implement if proven effective	ongoing
3.12	Research additional mechanical and chemical methods of control	ongoing
3.13	Determine optimal timing/conditions for control strategies	2 years
3.14	Encourage angler harvest of nonnative fish species	ongoing
3.15	Using monitoring data, identify the presence any new non-native species, the threat to listed species posed those non-native species, the source, and implement control measures as needed	ongoing

Activity Number	Activity Description	Activity Frequency (years)
Action 4	<i>Develop captive broodstock(s) from wild fish to maintain existing genetic diversity of populations in the Colorado and Green River subbasins. This action protects the extant genetic and life history lineages. Broodstock(s) should serve as a genetic refuge and provide offspring for augmentation programs where needed. If determined necessary to meet demographic recovery criteria, this action should include production, rearing, and stocking sufficient numbers of Colorado pikeminnow to meet stocking goals and augmentation plans.</i>	
4.2	Determine genetic makeup of collected fish	one time
4.3	Develop genetics management plan for producing fish that maintains the same genetic diversity as wild populations	one-time, revise as needed
4.4	Construct new facilities for Colorado pikeminnow production, as needed	one-time, review as needed
4.5	Operate and maintain facilities for propagation	ongoing
4.8	Evaluate stocking programs' progress in supporting recovery and maintaining genetic diversity and revise plans based on findings	ongoing, periodic
4.9	Improve hatchery rearing methods to increase survival and success of future reintroductions	ongoing, periodic
Action 5	<i>Conserve, or improve, native fish communities to provide a forage base for all life stages of Colorado pikeminnow in all subbasins. This action supports growth and survival of Colorado pikeminnow. Supporting native fish communities may include controlling nonnative fish to reduce impacts to native fish species and augmenting or reintroducing native fish species where necessary, in addition to implementing flow management described for Colorado pikeminnow.</i>	
5.2	Monitor native fish communities to determine response to mgmt. actions	ongoing
Action 6	<i>Create and maintain habitats for Colorado pikeminnow using mechanical restoration methods or flow management actions in all subbasins. This action provides necessary habitats through a variety of mechanisms, including if climate change causes natural hydrologic conditions to become insufficient to perform habitat maintenance functions. Flow management activities under this action might differ from those intended to directly benefit Colorado pikeminnow populations, such as flows to reverse negative effects of vegetative encroachment or to transport sediment.</i>	
6.1	Use flow management from reservoirs for habitat maintenance (may be different than activities listed in flow recs)	ongoing, periodic
6.2	Investigate methods to provide and maintain habitats (e.g., woody debris, cobble bar enhancement)	2–3 years
6.5	Develop and implement adaptive management plans to monitor habitat, determine response to management actions, and adjust habitat management actions as needed to maximize success	ongoing

<b>Activity Number</b>	<b>Activity Description</b>	<b>Activity Frequency (years)</b>
<i>Action 7</i>	<i>Develop partnerships to improve land management practices that may reduce water quality via runoff of contaminants or spills in all subbasins. This action protects stream water quality.</i>	
7.1	Identify potential sources of contaminants (pipelines, highways/bridges, railway spills, etc.) and assess risk; develop prevention/response plans	ongoing
7.2	Determine effects of contaminants on Colorado pikeminnow population dynamics	3 years
7.3	Develop partnerships to address upland sources of contaminants, pollutants, and/or increased erosion that could run off into river habitats	3 years
7.4	Work with state pollution control agencies to establish water quality standards for pollutants that are protective of all Colorado pikeminnow life stages	one-time, revise as needed
<i>Action 8</i>	<i>Operate dams to provide appropriate release water temperatures to meet life history requirements, specifically from Flaming Gorge Dam, Navajo Dam, and the Aspinall Unit. This action should be continued at Flaming Gorge Dam or enacted where feasible at the other locations if water temperatures are a limitation in achieving demographic recovery criteria.</i>	
8.2	Investigate potential for upstream expansion of Colorado pikeminnow as temperatures warm	1 year or less
<i>Action 9</i>	<i>Expand Colorado pikeminnow access into the greatest feasible extent of historically occupied range. This action increases the species' resiliency, redundancy, and representation, recognizing that Colorado pikeminnow is currently limited to a small portion of its former range. Implementation of this action might include exploring opportunities to reintroduce the species, constructing additional passage or improvement projects, or modifying existing structures where access is a limitation to achieving demographic recovery criteria. Warmer stream temperatures from climate change and future management actions could lead to improved habitats outside the current distribution for Colorado pikeminnow. Periodic assessments should be conducted to determine the suitability of additional reaches to contribute to recovery of the species, particularly in the LCRB.</i>	
9.3	Investigate potential to reintroduce Colorado pikeminnow into historically occupied reaches. This activity becomes more important if recovery criteria are not being met	1 year
9.4	Assess potential for reintroductions based on current and predicted future changes in river conditions and management	1 year
<i>Action 10</i>	<i>Prevent escapement of invasive fishes from source populations by constructing exclusion facilities, replacing invasive species in reservoirs with compatible sport fisheries, and eliminating sources where possible. This action reduces threats posed by the expansion of nonnative species into current range of Colorado pikeminnow.</i>	

<b>Activity Number</b>	<b>Activity Description</b>	<b>Activity Frequency (years)</b>
10.1	Operate and maintain existing exclusion facilities including screens, nets, and other containment facilities	ongoing
10.3	Use chemical renovations to remove problematic nonnative fish as needed	ongoing, periodic
10.4	Monitor effectiveness of containment facilities and eradication efforts	3–5 years
10.5	Monitor for invasions of nonnative fishes in tributaries and mount rapid response to prevent establishment	ongoing, periodic
10.6	Evaluate risks of nonnative fish escapement due to low reservoir elevations or reservoir flow management practices (e.g. spills, maintenance)	1 year or less
10.7	Identify, control, and/or prevent escapement from off channel sources of nonnative fish species including gravel pits and connected ponds	ongoing
<i>Action 11</i>	<i>Reduce illicit and unintentional movements of all invasive taxa that could become established in Colorado pikeminnow current range by conducting outreach, enacting regulations where needed, and enforcing regulations. This action reduces the risks posed by the introduction or establishment of additional invasive species.</i>	
11.1	Conduct outreach to prevent illicit introductions and unintentional movements of invasive species	ongoing
11.2	Identifying potential sources and risks of novel introductions of invasive species	ongoing
11.3	Evaluate impacts of other invasive species on Colorado pikeminnow habitats and populations	ongoing
11.4	Continue enforcement of applicable laws and regulations to address movement of invasive species	ongoing
11.5	Develop and implement a suite of suggested regulatory/enforcement approaches to address illicit fish introduction	one-time, revise as needed

## Green River Subbasin Activities

Activity Number	Activity Description	Activity Frequency (years)
1.1	Provide spring peak flows and strive to meet recommendations based on most recent information and analysis (Flaming Gorge, Duchesne, White)	ongoing but site-specific
1.2	Provide base flows where applicable and strive to meet flow recommendations (Flaming Gorge, Duchesne, White, Yampa)	ongoing but site-specific
1.3	Evaluate flow recommendations periodically as new information becomes available to assess whether they are meeting intended outcomes and achieving/supporting recovery. Revise flow recommendations as needed	ongoing, but basin-specific
1.4	Implement flow recommendation targets according to their prescribed frequencies, particularly for Yampa River base flows	ongoing
2.1	Maintain and operate existing fish passage facility at Tusher Wash Dam	ongoing
2.4	Study effectiveness of passages to determine actual fish use and improve where needed	every 3–5 years
2.5	Minimize native fish entrainment into water infrastructure at diversions	ongoing
2.6	Maintain and operate facilities that reduce Colorado pikeminnow entrainment into water delivery systems, specifically the Green River Canal Company fish screen	ongoing
3.1	Remove smallmouth bass and implement strategies to reduce reproductive success, (e.g., seasonal flow spikes)	ongoing until no longer needed
3.2	Remove walleye, especially in lower river reaches of the Green River	ongoing until no longer needed
3.3	Remove northern pike in the Yampa River basin and implement strategies to disrupt spawning	ongoing until no longer needed
3.4	Measure effects of control programs on the abundance, distribution, and reproductive success of target nonnative species	ongoing, periodic
3.5	Refine estimates of problematic nonnative fish species abundance reduction required to produce positive native fish response	2–4 years per nonnative fish species
3.9	Control escapement of non-native species from reservoirs through implementation, operation, and maintenance of fish screens on reservoir outlet works	ongoing
4.1	Collect wild fish to create or augment existing broodstock	periodic, as needed
4.6	Determine need for augmentation in the Green River subbasin and develop an augmentation plan (sizes, numbers, locations) as needed	one-time, revise as needed



<b>Activity Number</b>	<b>Activity Description</b>	<b>Activity Frequency (years)</b>
5.1	Reintroduce or augment native fish populations to restore fish communities, particularly native suckers in the Yampa River	ongoing, as needed
6.1	Use flow management from reservoirs for habitat maintenance (may be different than activities listed in flow recs)	ongoing, periodic
7.1	Identify potential sources of contaminants and assess risk to Colorado pikeminnow	ongoing
8.1	Continue operating Flaming Gorge Selective Withdrawal Structure to meet temperature recommendations from Muth/Lagory et al.	ongoing
10.1	Operate and maintain existing exclusion facilities including screens, nets, and other containment facilities	ongoing
10.2	Evaluate the need for additional reservoir containment solutions and construct where needed	1–3 years as needed

## San Juan River Subbasin Activities

Activity Number	Activity Description	Activity Frequency (years)
1.1	Provide spring peak flows and strive to meet recommendations based on most recent information and analysis (Navajo Reservoir)	ongoing but site-specific
1.2	Provide base flows where applicable and strive to meet flow recommendations (Navajo Reservoir)	ongoing but site-specific
1.3	Evaluate flow recommendations periodically as new information becomes available to assess whether they are meeting intended outcomes and achieving/supporting recovery. Revise flow recommendations as needed	ongoing, but basin-specific
1.4	Implement flow recommendation targets according to their prescribed frequencies, particularly for peak flows	ongoing
2.1	Maintain and operate existing fish passage facilities	ongoing
2.2	Manage flows to extend duration of passage operations and to allow access to passages	ongoing
2.4	Study effectiveness of passages to determine actual fish use and improve where needed	every 3–5 years
2.5	Minimize native fish entrainment into water infrastructure at diversions	ongoing
2.6	Construct, maintain, and operate facilities that reduce Colorado pikeminnow entrainment into water delivery systems	ongoing
2.8	Improve entrainment prevention facilities, if needed	periodic, as needed
3.4	Measure effects of control programs on the abundance, distribution, and reproductive success of target nonnative species	ongoing, periodic
3.5	Refine estimates of problematic nonnative fish species abundance reduction required to produce positive native fish response	2–4 years per nonnative fish species
3.6	Determine threat posed to Colorado pikeminnow by nonnative fish species in the San Juan River	periodic, as needed
3.7	Implement control of nonnative fishes in the San Juan River basin commensurate with the threat, as determined above	ongoing, as needed
4.7	Continue augmenting Colorado pikeminnow in the San Juan River subbasin basin	ongoing
4.8	Evaluate stocking programs' progress in supporting recovery and maintaining genetic diversity and revise plans based on findings	ongoing, periodic
5.1	Reintroduce or augment native fish populations to restore fish communities, potentially roundtail chub in the San Juan River	periodic, as needed

<b>Activity Number</b>	<b>Activity Description</b>	<b>Activity Frequency (years)</b>
6.1	Use flow management from reservoirs for habitat maintenance (may be different than activities listed in flow recs)	ongoing, periodic
6.2	Investigate methods to provide and maintain habitats (e.g., woody debris, cobble bar enhancement, removal of invasive channel-encroaching vegetation, etc.)	2–3 years
6.3	Assess the technical feasibility and cost of using mechanical restoration to produce habitat to achieve recovery criteria in the San Juan subbasin	one time
6.4	Construct secondary/low velocity habitats and increase/maintain channel complexity via mechanical methods	periodic, as needed
6.5	Develop and implement adaptive management plans to monitor habitat, determine response to management actions, and adjust habitat management actions as needed to maximize success	ongoing
8.3	Determine costs and demographic benefits to Colorado pikeminnow of temperature modifications at additional facilities (e.g., Navajo Dam)	periodic, as needed
9.1	Identify barriers to movement within current distribution	one time
9.2	Develop priority list for passage projects	one-time, revise as needed
10.1	Operate and maintain existing exclusion facilities including screens, nets, and other containment facilities	ongoing

## Upper Colorado River Subbasin Activities

<b>Activity Number</b>	<b>Activity Description</b>	<b>Activity Frequency (years)</b>
1.1	Provide spring peak flows and strive to meet recommendations based on most recent information and analysis (Aspinall, 15-Mile Reach)	ongoing but site-specific
1.2	Provide base flows where applicable and strive to meet flow recommendations (Aspinall, 15-Mile Reach)	ongoing but site-specific
1.3	Evaluate flow recommendations periodically as new information becomes available to assess whether they are meeting intended outcomes and achieving/supporting recovery. Revise flow recommendations as needed	ongoing, but basin-specific
1.4	Implement flow recommendation targets according to their prescribed frequencies, particularly 15-Mile Reach base flows	ongoing
2.1	Maintain and operate existing fish passage facilities: Grand Valley Project, Price-Stubb, GVIC, and Redlands	ongoing
2.2	Manage flows to extend duration of passage operations and to allow access to passages	ongoing
2.3	Provide adequate flows and maintain facility operations as much as possible during the time period(s) in which Colorado pikeminnow require passage to fulfill life history requirements	ongoing
2.4	Study effectiveness of passages to determine actual fish use and improve where needed	every 3–5 years
2.5	Minimize native fish entrainment into water infrastructure at diversions— Grand Valley Project, GVIC, Redlands	ongoing
2.6	Maintain facilities that reduce Colorado pikeminnow entrainment into water delivery systems. Specifically, Grand Valley Project, GVIC, and Redlands	ongoing
2.7	Investigate alternative devices and technology to minimize entrainment	periodic, as needed
2.8	Improve entrainment prevention facilities, if needed. Grand Valley Project, GVIC	2–3 yr per facility
3.1	Remove smallmouth bass and implement strategies to reduce reproductive success	ongoing until no longer needed
3.2	Remove walleye, especially in lower river reaches the Colorado River	ongoing until no longer needed
3.4	Measure effects of control programs on the abundance, distribution, and reproductive success of target nonnative species	ongoing, periodic
3.5	Refine estimates of problematic nonnative fish species abundance reduction required to produce positive native fish response	2–4 years per nonnative fish species

<b>Activity Number</b>	<b>Activity Description</b>	<b>Activity Frequency (years)</b>
4.1	Collect wild fish to create or augment existing broodstock	periodic, as needed
6.1	Use flow management from reservoirs for habitat maintenance (may be different than activities listed in flow recommendations)	ongoing, periodic
8.3	Determine costs and demographic benefits to Colorado pikeminnow of temperature modifications at additional facilities (Aspinall)	periodic, as needed
10.1	Operate and maintain existing exclusion facilities including screens, nets, and other containment facilities	ongoing

### Lower Colorado River Basin Activities

<b>Activity Number</b>	<b>Activity Description</b>	<b>Activity Frequency (years)</b>
4.5	Operate and maintain facilities for Colorado pikeminnow propagation; support and conduct research to assess recovery potential in Grand Canyon	ongoing, as needed
9.3	Investigate potential to repatriate reintroduce Colorado pikeminnow into historically occupied reaches.	periodic, as needed
9.4	Assess potential for Colorado pikeminnow reintroductions based on current and future river conditions, and water management. Conduct research to assess recovery potential in Grand Canyon	periodic, as needed

### Literature Cited

- U.S. Fish and Wildlife Service (Service). 2020. Colorado Pikeminnow (*Ptychocheilus lucius*) 5-Year Status Review: Summary and Evaluation. Department of the Interior, Upper Colorado Region, Lakewood, CO. 23 pp.
- U.S. Fish and Wildlife Service (Service). 2023. Recovery plan for Colorado pikeminnow (*Ptychocheilus lucius*). June 2023. U.S. Fish and Wildlife Service, Mountain-Prairie Region, Denver, Colorado. 28 pp.