Fish and Wildlife Program Categorical Assessment, 1980-2022: Non-native and Invasive Species

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This is a staff product and has not been reviewed or approved by the Council. This working draft functions as supplementary documentation for the Categorical Assessment presentations and contains information to inform the upcoming amendment process. While elements within this document were developed in collaboration with the region's state and federal fish and wildlife agencies and tribes, the document itself has not been reviewed by anyone other than Council staff and should be considered preliminary. We welcome feedback and/or corrections for future drafts of this documentation.

Northwest **Power** and **Conservation** Council

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Purpose

The objective of this assessment is to describe the status of management for non-native and invasive species under the Council's Fish and Wildlife Program over the last 40 years, and to describe key topics for the Council and region to consider as we approach the next Program amendment cycle. The Council's Program does not address all possible invasive or non-native species in the basin. Rather, it focuses on mitigation for the hydrosystem and that subset of invasive species that benefit directly or indirectly from the hydrosystem or affect other Program work to mitigate for the hydrosystem.

The Council defines a non-native species as an introduced species living outside its native newly invaded range and an invasive species as a species that establishes and reproduces rapidly outside its native range.

Relationship between the hydrosystem and non-native and invasive species

Since the 1990s, Programs have called for investigating the effect of non-native or invasive species on resident and anadromous fish, particularly if they were ESA-listed. The first calls for investigating these species included shad and brook trout in the 1990s followed by zebra and quagga mussels and others (Table 1).

The existence of hydropower dams can reduce or degrade ecosystem function. Specific hydrosystem impacts include alterations to flow, water temperature, and water quality, which create habitat conditions favorable to non-native and invasive species and native predators and change patterns of predation throughout the mainstem and estuary. Changes to the ecological function of rivers, lakes, the estuary, and the nearshore plume have also been observed. In addition, the drawdown and refill rates and volumes in reservoirs can exert a substantial impact on the food web in reservoirs, free-flowing reaches of rivers, and lakes. Prime examples of these impacts are in the river or river-lake ecosystems in Montana (e.g., Flathead and Kootenai systems; Beattie et al. 1988; Muhlfeld et al. 2011; FWP et al. 2017), and in northern Idaho (Lake Pend Oreille; Whitlock 2013) (NPCC, 2024).

Approach to mitigation

The non-native and invasive species sub-strategy in the 2014 Program and 2020 Addendum specifies that these species imperil native species in the Pacific Northwest's ecosystems through predation, competition for food, interbreeding, disease transmission, food web disruption, and physical habitat alteration. Invasive and non-native species pose direct threats to the Program's fish and wildlife restoration efforts through competition, predation and habitat modification. In addition, aquatic non-native species can invade and significantly threaten infrastructure at hydroelectric dams and fish passage facilities in the Columbia River Basin. In 2014, the greatest known threat in the Columbia River Basin from aquatic invasive species was- and still is- the introduction of zebra or quagga mussels. Other aquatic threats include hydrilla, silver carp, flowering rush, and Eurasian milfoil. Terrestrial invasive species that compromise fish habitat and wildlife mitigation projects include rush skeletonweed, yellow starthistle, poison hemlock, and Japanese knotweed, among others. Once established in other locales, management actions have shown little success in removing or controlling these invasive non-native species.

The Program has also acknowledged the effect that non-native and invasive species can have on biological diversity, which can in turn threaten the basin's ability to adapt to shifting environmental conditions due to climate change. Non-native species can increase diversity but can also disturb the connections between native species and reduce their ability to adapt and survive. This idea also contributes to the Program's fundamental, overarching strategy to support ecosystem function and is tied to sub-strategies like habitat and water quality.

The control of non-native and invasive species occurs through regional prevention and management efforts. Preventing establishment is the main goal, but if it occurs, then monitoring and control are the next steps followed by removal and eradication when possible. According to the Program, monitoring and control efforts should aim to: (1) detect the presence of these species early and respond rapidly, (2) educate the public; and (3) prevent, monitor, control, and stop or minimize the spread of non-native and invasive species where these pose both a direct threat to the hydropower system, to native fish, or to wildlife species. Supporting up-to-date

research and environmental risk assessment methodologies are principles of the Program, especially when the introduction of a non-native species is necessary for mitigation. None of these efforts are possible without significant regional coordination, to which the Council is deeply committed.

Program measures

The first measures on invasive species appeared in Programs in the 1990s and focused on shad and brook trout (Table 1). In the 2000s, the Program contained additional measures on invasive mussels and vegetation. Main themes in the Program highlight the need to eradicate non-native and invasive species from strongholds; monitor and evaluate nuisance species; control non-native/invasive species where they pose a threat; prevent establishment of zebra and quagga mussels; assess potential impacts of using non-native fish species for mitigation: evaluate effects on resident fish; and to sustain and support ongoing efforts to reduce predation by northern pike and brook trout. (Northern pike and brook trout are highlighted in the Predator Management chapter of the categorical assessments.) Over 20 different entities from all parts of the basin submitted recommendations concerning non-native and invasive species in the last amendment process.

Table 1. Development of non-native and invasive species measures and principles in the NPCC Fish and Wildlife Programs, 1991 – 2020

Years	Example measures *About 33 measures have appeared since 1991*
1991-1999	• **Evaluate** increasing shad populations • **Remove** brook trout • **Reduce** non-native fish populations where they occur with listed species
2000-2011	• Increased concern about non-native and invasive species • **Suppress** non-native populations that adversely affect salmonids (e.g., shad) • Policies for other invasive species noted (e.g., zebra and quagga Mussels, silver carp, Eurasian milfoil)
2012-2020	• **Eradicate** from strongholds • **Monitor, evaluate, and control** nuisance species • **Prevent establishment** of zebra and quagga mussels • **Assess potential impacts** of using non-native fish species for mitigation • **Develop public outreach tools** to educate the public about regional prevention and management of invasive species

2014/2020 Fish and Wildlife Program strategies associated with assessment

Table 2. Summary of Fish and Wildlife Program strategy and strategy performance indicators (SPIs; NPCC 2020) associated with the non-native and invasive species portion of the Habitat Assessment. All data can be found on the Program Tracker

Strategy ***SPI***	**Description**
Non-native and invasive species	Prevent the introduction of non-native and invasive species in the Columbia River Basin and suppress or eradicate non-native and invasive species
E5-1	Number of watercraft inspected and decontaminated in the northwest states of the Columbia River Basin for zebra/quagga mussels
E5-2	Ratio of positive detections of zebra/quagga mussels to number of inspected watercraft

Implementation

Zebra and Quagga Mussels

Background and risks from invasion

A major issue in the current decade has been invasive zebra and quagga mussels. Prior to 2023, the Columbia Basin had been the only major river basin in the U.S. that was not impacted by establishment of zebra and quagga mussels. Where they have been introduced elsewhere, they can clog up hydrosystem infrastructure and disrupt the ecosystem. Zebra and quagga mussels multiply rapidly, clogging pipes and intake structures.

The potential economic, hydropower, and ecological impacts from invasive quagga mussels should not be underestimated. Critical infrastructure could be at risk including the hydropower system and associated fish passage, hatcheries, irrigation, fish screens, navigation, municipal water, recreational facilities including boat ramps and golf courses, and data center cooling systems.

Harmful ecological impacts also result from zebra and quagga mussel introductions. Potential serious threats to food webs can negatively transform ecosystem productivity and undermine species mitigation and conservation efforts. Tribal trust and treaty obligations will be harder to meet with a diminished capacity to restore and conserve ecosystem value.

A 2024 presentation to the Council by Nic Zurfluh, Invasive Species Bureau Chief Idaho State Department of Agriculture, and Justin Bush, Aquatic Invasive Species Policy Coordinator

Washington Department of Fish and Wildlife detailed some of the economic and environmental risks summarized here:

Economic risks:

- $100 million annual hydroelectric mitigation and maintenance
- $12.8 billion value of agricultural production > 75% irrigated agriculture (> $9.6 B) (2024)
- $35.5 million in state boating related revenue annually (2010)
- $21.5 billion annually spent on outdoor recreation 27% involving public waters (> $5.0 B) (2020)

Environmental risks:

- Outcompete beneficial species
- Filter feeding impacts phytoplankton structures and increases bacteria
- Water quality changes including reduced oxygen levels, increases in water transparency and aquatic weeds
- Mussels bioaccumulate pollutants impacting the food chain through increased exposure
- Severe risk to cultural resources, threatened and endangered species, and human health

Summary of implementation

The Council's 2014 Columbia River Basin Fish and Wildlife Program calls the introduction of zebra or quagga mussels "the greatest known threat in the Columbia River Basin from aquatic invasive species" (P. 46). Prior to 2023, the Columbia Basin was the only major river basin in the U.S. that had not been impacted by zebra and quagga mussels. The Council highlighted this as an emerging priority in 2014, urging the Army Corps of Engineers to help fund detection and response actions.

The states of Idaho, Montana, Oregon, and Washington have watercraft inspection stations in place to prevent aquatic invasive species from unintentional transport into Columbia River Basin waters. All four states continue to encounter boats transported with attached invasive mussels. Rapid Response Plans exist in each state so that effective and organized action can respond to possible detections. Each state has continued to advocate and work to secure additional funding to address and further prepare for quagga mussel prevention actions. In some cases, new laws have been adopted.

Through 2021, as watercraft inspections plateaued or decreased in all states except Oregon, the number of detections increased (Figures 1, 2).

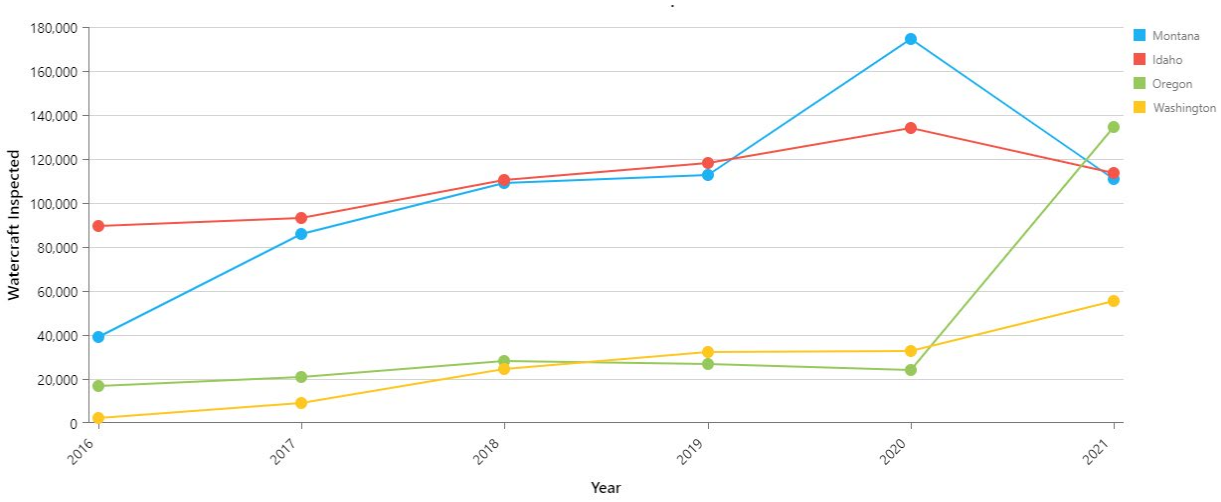

Figure 1. Number of watercraft inspected for zebra and quagga mussels each year in the Columbia Basin by the states of Montana, Idaho, Oregon, and Washington. Data reported on the Program Tracker under SPI E5-1.

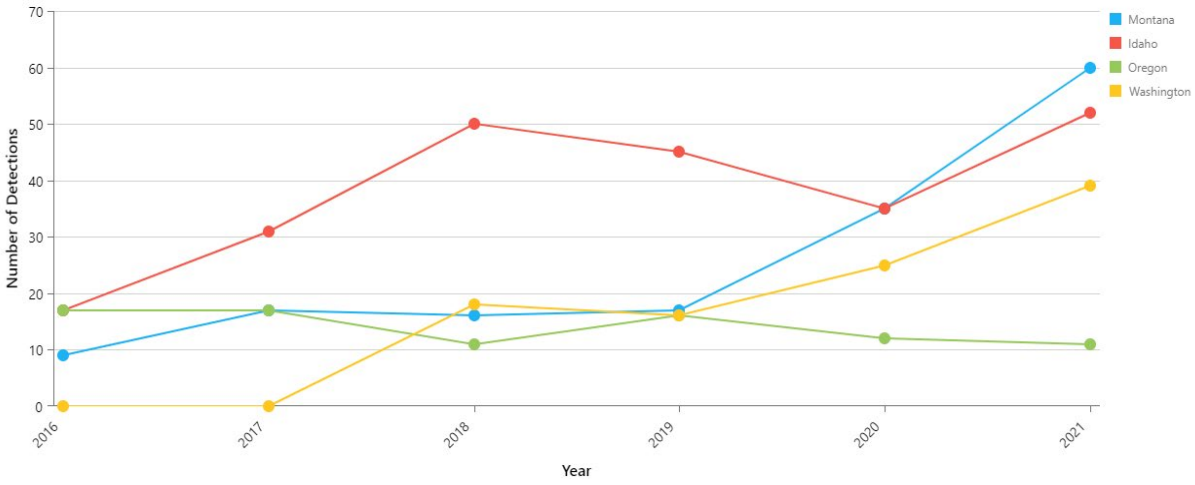

Figure 2. Number of detections of zebra and quagga mussels each year in the Columbia Basin during watercraft inspections by the states of Montana, Idaho, Oregon, and Washington. Data reported on the Program Tracker under SPI E5-1.

Discussion

In the Columbia Basin, invasion and establishment of zebra and quagga mussels could negatively impact substantial mitigation work implemented under the Fish and Wildlife Program.

For almost 20 years, the cumulative efforts of Columbia River Basin states and provinces prevented the introduction and so far have prevented the establishment of invasive freshwater quagga and zebra mussels. Routine early detection monitoring performed by the Idaho State Department of Agriculture in the fall of 2023 detected free-floating quagga mussel larvae. This

triggered notification by the Governor of Idaho and implementation of the Columbia River Basin invasive mussel rapid response plan. SCUBA surveys also located a single adult quagga mussel during scoping for a rapid response treatment performed in October 2024. The Council has received updates on these rapid responses and will continue to do so.

Links to more information on the Snake River situation:

- IDFG info page: Quagga Detection on Snake River
- ID DOA November 2023 Council presentation: Quagga Mussel Detection and Response in the Snake River, Idaho
- NPCC, December 2023: Idaho Acts Quickly After Detecting Quagga Mussel Larvae in the Snake River
- NPCC, August 2024: Protecting the Columbia Basin from invasive quagga mussels
- ID DOA, WDFW, August 2024 Council presentation: Update on Response to Detection of Quagga Mussels

Highlights:

- The Program has consistently called upon action agencies to strengthen management actions regarding zebra and quagga mussels over time.
- Extensive early detection and treatment programs are in place across the Columbia Basin and have been implemented in the past two years.
- Additional resources and attention have been provided in response to the detection of quagga mussels in the Snake River.

American Shad

Background and risks from invasion

American shad are an anadromous species and were introduced to the Sacramento River in 1871 (ISAB 2021); from there they invaded the Columbia River and rapidly increased in abundance.

- *Alosa sapidissima* – part of the herring family
- Large, but passable, hydropower dams and their associated reservoirs have created near-optimal conditions for shad spawning and rearing (Figure 3)
- Shad tolerate a wide range of temperature, flow, turbidity, salinity, and other aspects of water quality and quantity
- Produce many eggs, ability to quickly build up populations
- Anadromous but can spawn multiple times
- There are likely ecological connections between shad and salmonids

- The peak of return in June overlaps with spring + summer salmon.

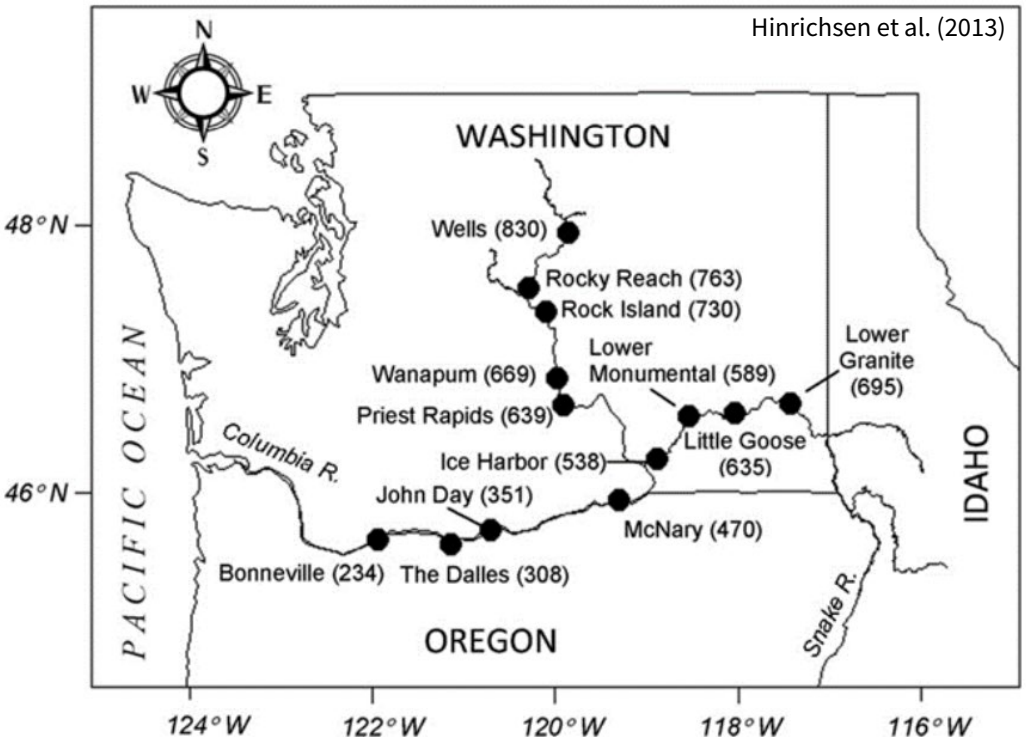

Figure 3. Passable dams on the mainstem Columbia and Snake rivers along the migratory route of American shad. Numbers show distance in river kilometers (km) from the mouth

American shad counts over Bonneville Dam have produced four peak returns since 2019 (Figure 4). Since 1970, more shad have passed Bonneville than salmon and steelhead combined in a given year, about 76% of the time.

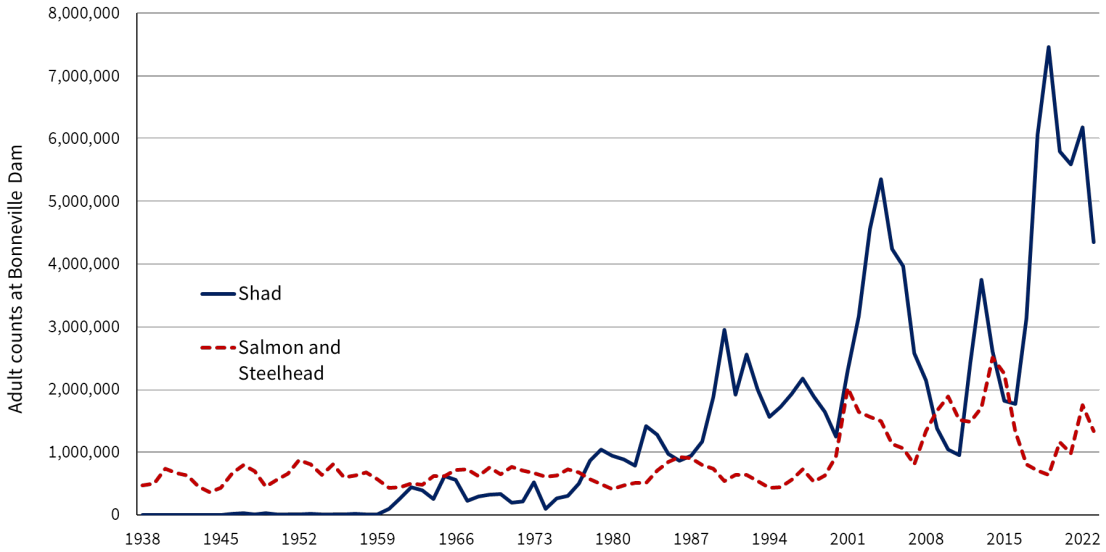

Figure 4. Counts of adult American shad (blue line) and adult salmon and steelhead species, combined (red dashed line) at Bonneville Dam, 1938 to present

Since their introduction, shad rapidly expanded as the hydropower system developed, taking advantage of passage facilities for native salmon species to colonize the upriver reaches of the basin. As mentioned, they are biologically well suited to the Columbia Basin's rivers, and they thrive in the chain of reservoirs in the Columbia River. They tolerate a wide range of temperature, flow, turbidity, salinity, and other aspects of water quality and quantity; and they produce large numbers of eggs, so they can build up populations quickly (NPCC, 2021). As temperatures increase with climate change, warmer, more variable conditions are likely to accelerate the decline of native species while favoring non-native species like shad. The lack of a strong fishery to decrease shad numbers exacerbates the problem.

In October 2001, the ISAB summarized the history of shad in the Columbia Basin and identified areas of concern for future research and monitoring in a report titled, "American Shad in the Columbia River: Past, Present, Future".

Table 3. Key points raised in the 2021 ISAB report on American shad

2021 ISAB Report	• Answering questions about the impact of increasing shad on salmon is an important challenge. *How should this be done?* • Focused research and monitoring • Better describe life history patterns of the Columbia River population • Model interactions between shad and native species in a variety of scenarios to inform future on-the-ground research

The 2021 ISAB report summarized previous Council work and raised concerns about the impact of an expanding shad population in the Columbia River Basin:

> *The 1994 Columbia Basin Fish and Wildlife Program included a measure to "explore the population ecology of shad to determine effective methods for control and develop programs to eliminate shad from the Columbia River system above Bonneville Dam and reduce the shad population below Bonneville Dam" (NPCC 1994, p. 5-45). In addition, the 2004 lower Columbia subbasin plan called for reducing shad abundance to a range of 700,000 to 1,000,000 adults (Lower Columbia Fish Recovery Board 2004, p. 3-111). The rationale for such actions appears to be largely speculative, given the paucity of directed research or monitoring data and analyses, and ultimately, concerted reduction efforts have not been pursued.*
>
> *Despite their abundance in the basin, management agencies have invested little effort to manage or study shad, in large measure because of other critical priorities. Their sheer numbers suggest there should be interactions with other fishes and with the birds and mammals that prey on them. However, the limited studies available do not identify clear interactions between shad and salmon or the role of shad in major ecosystem processes. A systematic, multiyear research program would be needed to address the questions posed in this document and to improve our understanding of the direct and indirect interactions of all life stages of shad with all life stages of anadromous salmonids, as well as with other organisms.*

Summary of implementation

Table 4. Summary of Program measures related to American shad over time

1994 Program	Control and eliminate shad above Bonneville and reduce below Bonneville.
2004 Program	Reduce shad abundance
2021 ISAB Report	Answering questions about the impact of increasing shad on salmon is an important challenge. *How?* • Focused research and monitoring. • Better describe life history patterns of the CR population. • Model interactions between shad and native species in a variety of scenarios to inform future on-the-ground research.

- 2021 ISAB Report
- No targeted fishery

- No targeted management actions
- Lack of understanding around the impact on salmon, steelhead, and other native species

Discussion

- More research and coordination are needed if active population management is to occur.
    - Other critical priorities have taken precedence over shad despite their abundance.
    - A systematic, multiyear research program would be needed to address uncertainties and to improve our understanding of the direct and indirect interactions of all life stages of shad with all life stages of anadromous salmonids, as well as with other organisms (ISAB, 2021).
- As shad populations increase, so do the threats to native fishes.
    - Greater competition for food and critical nursery habitat
    - Predation on salmon young
    - Disease transmission
    - Increasing predator populations
- At such high numbers, shad can interfere with operations to aid adult salmon returns upriver by:
    - Obstructing the counting of salmon
    - Lowering oxygen concentrations at collection facilities
    - Complicating accurate identification of migrating salmon and steelhead in fish counting facilities
- Likely ecological connections between shad and salmonids:
    - Diet and competition
    - Predation
    - Thiamine deficiency is a proposed possibility by ISAB (if salmon predate on juvenile shad could produce neurological/reproductive issues and mortality) (pg. 47, ISAB, 2021).

Still, the abundance of both shad and salmon depends on the health of the river and reservoirs; the estuary; and above all, the ocean. The winds and currents that create this productivity may become even more erratic because of climate change, so populations of shad, other fishes, and their predators are likely to fluctuate widely and unpredictably.

General Discussion

Non-native and invasive species measures have increased in recent Programs.

- Continued prioritization of non-native and invasive species research, monitoring, and evaluation is imperative in a dynamic system like the Columbia River.
    - Climate change
    - Human demands
    - Operational changes
- The Columbia River Basin is highly modified and complicated.
    - Opportunities for adaptive management?
    - What kind of future planning might be needed?
- What about species that aren't managed?
    - Carp
    - Spotted Lanternfly
    - Invasive vegetation species
    - Non-native clams and snails
    - Tiger muskie
    - Red-eared slider turtles
    - European green crab
    - Other species whose invasions threaten existing Program investments (e.g. in restoration, reintroduction, etc.)?
- Prioritization of non-native and invasive species research, monitoring, and evaluation should be considered in a changing basin.
    - Shifting climate regimes often benefit invasive and non-native species.
    - Human demands on the ecosystem affecting flow, temperature, etc. may exacerbate these changes.
- The Columbia River Basin is highly modified and complicated.
    - Emerging niches may benefit non-native and invasive species
    - Anticipation may help improve management and protection of native species or species of concern.

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