

California Fish and Game Commission Wildlife Resources Committee

Introduction to the Staff Report on the American Bullfrog and Non-Native Turtle Stakeholder Engagement Process

May 12, 2023

Since 2018, California Fish and Game Commission (Commission) staff has led a stakeholder engagement process with three stakeholder groups to identify potential regulatory and statutory changes, funding mechanisms, and strategies for reducing the impacts of existing populations of American bullfrog (commonly referred to as bullfrog) and non-native turtles on California's native wildlife. The first group of stakeholders was composed of representatives from local, state and federal government agencies, the second from environmental and animal welfare groups, and the third from various commercial sector and industry groups. Staff sincerely thanks the many participants in the stakeholder process for their extensive time commitment and diligence and for sharing their expertise.

Attached is the final Commission staff report, communicating the results of the stakeholder process, staff's analysis of those results, and staff recommendations for the identified strategies. As an aggregate of the collective judgments and analyses of all the participants in the process, the staff report is comprehensive in scope. Yet the report is simultaneously and necessarily limited by participants' knowledge and experience. It is important to understand that there may be resources, strategies, and other information that is not captured simply because participants—including staff—were unaware of them. Along those lines, staff has become aware of both a promising strategy and a valuable source of information, a potential volunteer testing program.

Potential Voluntary Testing Program

A team of researchers at the University of Tennessee (UT) is collaborating with the Pet Advocacy Network (formerly the Pet Industry Joint Advisory Council¹) and other partners on a voluntary program of testing turtle imports for disease. The approach is in its formative stages but may be a constructive avenue for exploration by the Commission and/or the California Department of Fish and Wildlife. The strategy was not identified by the stakeholder groups and is therefore not identified in this staff report.

Under the voluntary testing system, importers, wholesalers, retailers, hobbyists, and other handlers of amphibians within the trade network would voluntarily quarantine and submit samples from their store of animals to qualified disease testing facilities. Arrangements for low-to-no-cost participation, anonymity of testing, and incentives are being explored. Eventually, a certification program may be introduced, so that end consumers could be assured that their purchase has been verified to be disease free, which may be attractive from both a reliability-of-purchase and an environmental standpoint. Importantly, the program is still in development

¹PIJAC had a representative on the industry group in the bullfrog and non-native turtle stakeholder engagement process.

and testing, and has not yet been widely deployed. More information on the nascent program can be found [here](#).

Pet Sector Research

Additionally, as part of the project, the UT team initiated a research survey of U.S. owners and businesses in the amphibian trade network. The results of the survey were published in a report in *Amphibian Consumer and Business Survey*, an executive summary of which can be found [here](#). The specific objectives of study, as identified in the report, were to:

- (1) Characterize the size and composition of the U.S. pet businesses that are engaged in the pet amphibian trade;
- (2) understand the awareness and attitudes that amphibian pet businesses and owners have with respect to harmful and beneficial microbes;
- (3) estimate the value businesses and owners place on amphibians free of pathogens such as ranavirus (Rv), *Batrachochytrium dendrobatidis* (Bd), and *Batrachochytrium salamandrivorans* (Bsal); and
- (4) characterize the current husbandry practices of amphibian pet dealers and owners, and their willingness to engage in proactive strategies that promote beneficial microbes and reduce harmful microbes in their facilities and the broader amphibian pet trade.

The report contains valuable insights into the trade network of U.S. amphibian handlers and serves as a valuable complement to the attached staff report. Lack of knowledge of the breadth and scope of this sector of the pet trade was consistently identified by stakeholders in the engagement process as a limiting factor in formulating situation analyses and appropriate strategies oriented towards the pet trade. As such, the report bridges a critical gap in knowledge and may help inform Commission and California Department of Fish and Wildlife decisions.

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Revised May 12, 2023

Executive Summary

Since 2018, California Fish and Game Commission (Commission) staff has led a stakeholder engagement process with three stakeholder groups to identify potential regulatory and statutory changes, funding mechanisms, and strategies for reducing the impacts of existing populations of American bullfrog (commonly referred to as bullfrog) and non-native turtles on California's native wildlife. The first group of stakeholders was composed of representatives from local, state, and federal government agencies, the second from environmental and animal welfare groups, and the third from various commercial sector and industry groups.

The three groups worked separately but in parallel, using a flexible, comprehensive process to guide their analyses. The groups identified ecological entities under threat from bullfrogs and non-native turtles, human well-being values at risk, the threats to various conservation targets and values, and a suite of specific strategies to address those threats. Altogether, stakeholders elicited a portfolio of 34 different solutions across 6 different strategic categories. Strategies were assessed for feasibility and controversy. This report includes draft recommendations from Commission staff for each strategy independently as well as for "bundles" of strategies which, when implemented together, may complement and enhance their effectiveness.

Key insights from the stakeholder process include:

- The California Department of Fish and Wildlife, as the primary wildlife management agency and, therefore, key to implementing many of the strategies, would undoubtedly require additional resources to execute any significant strategy. However, strategies cross all sectors of California – private, public, and non-profit.
- There was significant disagreement about the need for, and effectiveness of, increased regulation and enforcement. Much of the disagreement stems from important informational unknowns. Concerted monitoring and research efforts to fill these knowledge gaps would allow better quantification of the relative risk caused by various ecological threats, which would in turn improve the assessment of strategies and their anticipated effectiveness.
- Any successful plan to address the impacts of bullfrog and non-native turtles populations should include a significant education component. All three groups emphasized the need for education not only of the broad public but of specific sectors (such as pet owners and live market retailers).
- Many strategies have broad economic and/or cultural consequences; their evaluation involves weighing tradeoffs, which is ultimately a normative exercise, that is, whether or not they are prudent will involve value judgments.

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Introduction

Annually there are approximately two million non-native American bullfrogs and 300,000 non-native turtles (mostly red-eared sliders and softshell turtles) imported into California for human consumption and the pet trade. Even though these species are not imported into California with the intention of being released, they have established wild populations that threaten native amphibians, fish, and other wildlife through direct predation, hybridization, competition for resources and habitat, and disease.

Background

The American bullfrog was introduced into California in the 1910s for aquaculture production and has become established throughout the state. The American bullfrog is one of the largest frogs in the U.S. and is highly adaptive. They have broad climatic and habitat tolerances, a generalist diet, strong defenses against predation, and high fecundity, all contributing to their successful establishment in California.

Escapees have likely contributed to the spread of bullfrogs within California and may have contributed to the introduction of amphibian diseases including chytrid fungus (also called *Bd*) and various ranaviruses. Bullfrogs have tested positive for both *Bd* and ranaviruses at aquaculture facilities in countries of origin and in endpoint markets, including California. These diseases contribute significantly to the amphibian mass death events occurring worldwide.

Non-native turtles have also been introduced to California and some species have established extant populations. However, the primary invasive turtle species is the red-eared slider, which can serve as a vector for disease and can outcompete native turtles and other native herpetofauna. Turtles are imported for human consumption and as pets.

There are diverse public opinions on the import/sale of bullfrogs and non-native turtles, with three primary conflicting interests. One segment of the public is involved in marketing them for human consumption; this practice has considerable cultural significance to these communities. Another is opposed to live animal markets due to threats to native amphibians from disease, hybridization, competition, and predation; a portion of this segment is also opposed due to animal welfare concerns. Finally, pet industry sales of non-native frogs and turtles are significant in California and occur with minimal disease monitoring or regulatory restrictions.

History and Process

In Feb 2015, the California Department of Fish and Wildlife (Department) prepared a report regarding the implications of American bullfrog importation, and notified the California Fish and Game Commission (Commission) of its decision to stop issuing long-term importation permits and to only issue short-term individual event permits, consistent with Section 236(c)(6)(l) of Title 14. In Apr 2017, The Commission directed its staff, in cooperation with the Department, to develop a proposal for stakeholder engagement to further evaluate possible solutions to address the impacts of American bullfrogs and non-native turtles on native wildlife. The staff proposal was presented to the Commission in Oct 2017 and revised in Oct 2018. In Dec 2018, the Commission referred the stakeholder process to its Wildlife Resources Committee to track progress in implementation and potentially provide recommendations back to the Commission. The plan involved three independent groups developing situation analyses and strategies for addressing the threats, challenges, and opportunities posed by bullfrogs and non-native turtles and their impacts on native wildlife.

For the situation analyses and strategies components, three independent groups were formed composed of representatives from different spheres of California society that have a vested interest in bullfrog and non-native turtle concerns. The first group was composed of representatives from local, state, and federal government agencies, the second from environmental and animal welfare groups², and the third from various commercial sector and industry groups. The groups met separately and worked on the same task (in parallel) to analyze: (1) threats to California's environment posed by bullfrogs and non-native turtles, (2) benefits and cultural values of bullfrogs and turtles in California's communities and other intersections with human well-being values, (3) knowledge gaps in our understanding of the relevant systems and operative biological processes, and (4) opportunities for progress in addressing the issues posed by invasive bullfrogs and non-native turtles in California's environment.

The process the groups utilized, called the *Open Standards for the Practice of Conservation* (see <https://conservationstandards.org/about/> for more information), entails several steps:

1. Scope and vision: Define the scope and vision for the project.
2. Targets: Identify the conservation targets (entities to be conserved/restored) and the human well-being aspects that are affected by the problems or may be affected by the proposed solutions.
3. Threats: Identify the proximate and indirect threats to the targets.
4. Threat ranking: (Optional) Rank the threats to gain an understanding of the key pressures on the targets.
5. Strategies: Identify strategies which may abate the various threats to the targets.
6. Results chains: Ground-truth each strategy, by formulating a theory of change through which the strategy addresses the threats and leads to positive change for the applicable target(s).

The groups created detailed situation analyses, embodied in diagrams which map the biological and social connections between various strategies, the threats they address, and conservation and human well-being targets they could be expected to affect. They then created results chains which illustrate the explicit mechanisms by which each strategy may be expected to influence the conservation threats and other factors, to help confirm that strategies realistically can be implemented. These materials, along with explanatory notes from the participants, may be found in Appendix A.

After the groups completed their individual analyses, Commission staff evaluated each strategy for its effectiveness and anticipated level of controversy. Staff then used this information, together with understandings gained from the stakeholder process, to create recommendations to the Commission Wildlife Resources Committee on the suitability of each stakeholder-developed strategy, both individually and in concert with other strategies. During staff's strategy assessment, the three stakeholder groups had several opportunities for input and cross-group dialogue, to clarify and discuss both the approaches taken by the other groups and Commission staff's assessment. This led to refinement of the staff analysis. The entire process, from stakeholder recruitment to this final staff report, took several years to complete.

² With respect to the environmental/animal welfare group, the terms "environmental" and "animal welfare" are intended to connote the primary orientation for broad types of certain stakeholder organizations, not attitudes or philosophies inherent to any organization. It should be recognized that governmental agencies and industry groups are also concerned with the welfare of animals and with protecting California's environment.

Important Stakeholder Insights

- Native California species that are particularly vulnerable to impacts from bullfrogs and non-native turtles include frogs, toads, and fish – particularly special status taxa (e.g., threatened, endangered, candidate, special concern). Based on the effects to the many conservation targets (i.e., California’s native species), the increased demand for water emerged as a very high threat to species, as the lack of water exacerbates non-native impacts to special status species. High-level threats across all species included *Bd*, ranaviruses, competition, habitat fragmentation, and habitat quality.
- The Department, as the state’s primary wildlife management agency and therefore the implementing entity for many of the strategies, would undoubtedly require additional resources to execute any significant strategy. However, strategies cross all sectors of California society – public, private, tribal, academic, and non-profit.
- There was significant disagreement about the need for, and effectiveness of, increased regulation and enforcement. Much of the disagreement stems from important informational unknowns. Concerted monitoring and research efforts to fill these knowledge gaps would allow better quantification of the relative risk caused by various ecological threats, which would in turn improve the assessment of strategies and their anticipated effectiveness.
- Any successful plan to deal with bullfrog and non-native turtles should include significant outreach and education components. All three groups emphasized the need for education not only of the broad public, but of specific sectors (such as pet owners and live market retailers).
- Many strategies have broad economic and/or cultural consequences. Their evaluation involves weighing tradeoffs, which is ultimately a normative exercise – that is, whether or not they are prudent or will involve value judgments.
- There is some risk in implementing strategies to combat use of a particular species as some users may shift to using another species. Some stakeholders emphasized a broad-brush approach which would instantiate a precautionary principle, while others favored a narrowly-tailored tactic which considers the environmental risk that could be anticipated by each species.
- Stakeholders raised the prospect of a bullfrog bounty, which also runs the risk of creating a market; potentially leading to cultivation and widespread non-target collection. Bounties were ultimately rejected as a viable strategy.
- Local municipalities can play an important role in non-native species control. The city of Santa Cruz enacted a ban on the sale and collection of bullfrogs in Santa Cruz. There is no specific mechanism for enforcement; enforcement is largely complaint driven. Santa Cruz has conducted outreach to pet stores. While the impacts on local frog populations may not be readily apparent, success is difficult to appraise in the absence of a concerted monitoring effort. Effectiveness may be greatly increased if a cluster of geographically proximate localities were to enact similar restrictions. The gains made in Santa Cruz could serve as a model for other municipalities.

California Fish and Game Commission Policy on Non-Native Turtles and Frogs

In April 2010, the Commission adopted a new policy highlighting the threat from importing non-native turtles and frogs and affirming that the Department shall cease issuing importation permits for any live non-native turtles or frogs pursuant to Commission regulations. The new policy was intended to be accompanied by changes to Section 236 of Title 14 of the California Code of Regulations; in the interim, the policy as adopted still stands.

The Fish and Game Commission declares that:

1. The Fish and Game Commission and the Department of Fish and Game have been charged by the Legislature to protect and wisely manage the State's living natural resources and the habitats upon which they depend.
2. The importation of non-native turtles and frogs poses threats not only to the State's native turtles and frogs, but also to the native source populations of the imported turtles and frogs.
3. These threats include, but are not limited to: disease, hybridization, competition, and predation.

Therefore, it is the policy of the Fish and Game Commission that the Department of Fish and Game shall cease issuing importation permits for any live non-native turtles or frogs pursuant to Section 236, Title 14, CCR.

(Adopted: 4/8/2010)

Given that the policy does little more than reiterate that the Department should comply with Section 236, the Commission may wish to consider amending or repealing the policy as part of the Commission's review of all its policies.

Oregon Case Study and Regulatory Framework³

For comparison purposes, the states of Oregon and Washington do not allow the importation of American bullfrogs. Also, the state of Oregon does not allow the importation of Apolone or Trachemys species of non-native turtles. In Oregon, non-native bullfrog and turtle populations are reproducing naturally. Oregon currently does not have an active eradication program because the populations are already well-established.

Bullfrogs are a "controlled" species, which means that exporting them is also prohibited. Most water turtles from North America, Europe and Asia are not allowed to be sold, but selected non-native species that are thought to be unable to survive in the wild are allowed to be sold. Sometimes they are surrendered by owners or are found moving to nesting grounds and are turned over to the Oregon Department of Fish and Wildlife (ODFW) and humanely euthanized. Importing through online sellers, particularly from Florida, continues to be a problem.

Schools can apply for a permit and may be allowed to import bullfrogs, so long as they are kept contained and eventually are euthanized. Bullfrogs often come into Oregon as tadpoles inadvertently included in shipments of aquatic plants.

Enforcement depends on the field district. There is no inspection system for commercial trade; enforcement actions typically manifest through complaints or through online venues (e.g., Craigslist), or when ODFW personnel personally check stores. ODFW has sole jurisdiction over these matters, though volunteers often monitor online venues and report suspected violations.

³ Based on a conversation with, and reviewed by, R. Boatner, Oregon Department of Fish and Wildlife.

Summary of Strategies

The three stakeholder groups identified 34 strategies that potentially could be used in California for addressing American bullfrog and non-native turtle concerns.⁴ Table 1 provides a quick assessment of each strategy for effectiveness, level of controversy, and key actors.

For each strategy, *Effectiveness* ranks are low efficacy, potentially effective, effective, and very effective (see the report section *Methods Used to Assess Strategies* for an explanation of how these ranks were developed).

Level of controversy is an estimate of opposition/acceptance from all stakeholders.

Key actors represents an assessment of the various sectors of society that would potentially be involved in implementing the strategy – some of these actors are critical while others may be optional. Question marks indicate either uncertainty about whether a key actor’s involvement would be important to implement the strategy, or that a particular actor may or may not be involved, depending on the particulars of how a strategy is implemented.

Table 1: Summary of Strategies Identified by Stakeholders

Key: **DFW** = California Department of Fish and Wildlife; **Leg** = California State Legislature; **Fed** = Federal partners; **Public** = Various stakeholder groups and organizations; **Localities** = Local municipalities, water agencies, and/or counties; **Private** = Private landowners or businesses

Strategy	Effectiveness	Level of Controversy	Key Actors
1. More resources for DFW	Effective	Low	Leg, DFW
2. Raise permit prices	Potentially Effective	Medium	DFW, Commission?
3. DFW grant program	Potentially Effective	Low	DFW, Leg
4. Research into release “inputs”	Very Effective	Low	DFW, Fed
5. Research on discharge	Potentially Effective	Low	DFW, Fed
6. Research into live food as vectors for disease	Very Effective	Low	DFW, Fed
7. Research into population control techniques	Potentially Effective	Low	DFW, Fed
8. Encourage wild collection	Potentially Effective	Low	DFW, Commission?

⁴ In some cases, different groups identified strategies that were identical or substantially similar; such duplicate strategies have been combined.

Strategy	Effectiveness	Level of Controversy	Key Actors
9. Bullfrogs as bait	Low Efficacy	Low	DFW
10. Education campaign 1 (Live markets)	Potentially Effective	Low	DFW, Public
11. Education campaign 2 (Pets)	Potentially Effective	Low	DFW, Public
12. Education campaign 3 (All-Encompassing)	Very Effective	Low	DFW, Public
13. Increased compliance with animal release regulations	Potentially Effective	Low	DFW
14. Habitat improvement	Potentially Effective	Low	DFW
15. Localized eradication	Effective	Low	DFW
16. Use of private land eradication of fish	Effective	Low	Leg?, Commission, DFW, Private
17. Ban sale of live bullfrogs	Effective	High	Commission
18. Point of sale inspections	Potentially Effective	Medium	DFW
19. Domestic bullfrog/turtle aquaculture	Potentially Effective	Low	Commission, DFW, Private
20. Testing and monitoring regime	Potentially Effective	High	DFW
21. Increase information collection through permits	Low Efficacy	Low	DFW, Commission
22. Promotion of programs for unwanted animals	Low Efficacy	Low	DFW, Public
23. Dispatching bullfrogs in contests	Effective	High	Commission, DFW
24. Ban frog jumping contests	Low Efficacy	High	Leg, Commission?
25. Contest monitoring/enforcement	Potentially Effective	Medium	DFW

Strategy	Effectiveness	Level of Controversy	Key Actors
26. Encourage/Allow use of other species with lesser effects	Potentially Effective	High	DFW, Commission, Leg?
27. Water & reservoir management	Potentially Effective	Medium	DFW, Localities, Private
28. Ban bullfrog imports	Effective	High	Commission
29. Develop commercial harvesting	Potentially Effective	Medium	Commission, DFW, Private
30. Add non-native turtles to restricted species list	Low Efficacy	High	Commission
31. Add bullfrogs to restricted species list	Low Efficacy	High	Commission
32. Prevent water contamination	Potentially Effective	Low	Commission
33. Ensure shipments are lawfully obtained	Potentially Effective	Low	DFW
34. Inspect shipments for illegal imports/mixing species	Potentially Effective	Low	DFW

Summary Statistics for Strategies

Goals, categories, and effectiveness ratings are not evenly divided among the collection of strategies in this report. Decision makers may wish to select a portfolio of strategies that reflects either balance across, or emphasis on, certain goals, efficacies, or approaches.

Figure 1: Number of Times Goals are Represented Across Strategies

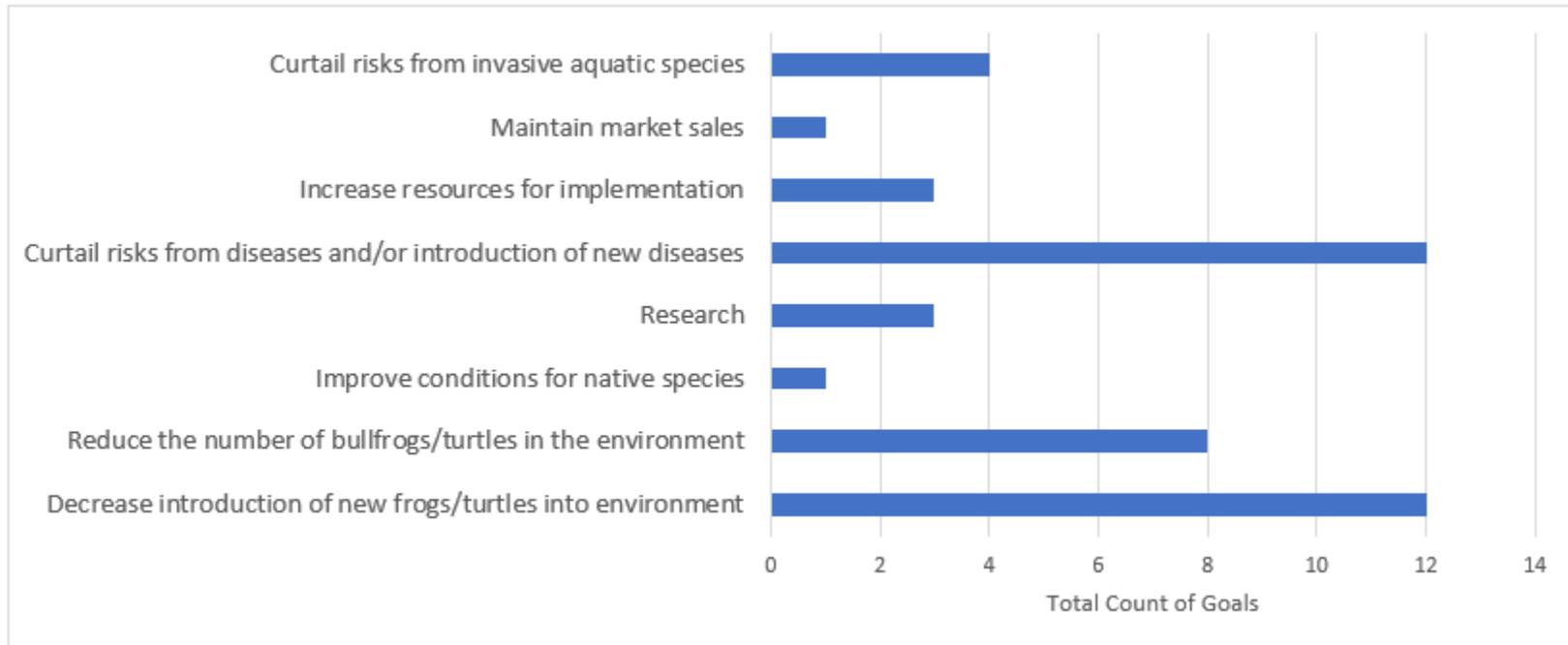


Figure 2: Effectiveness of Strategies

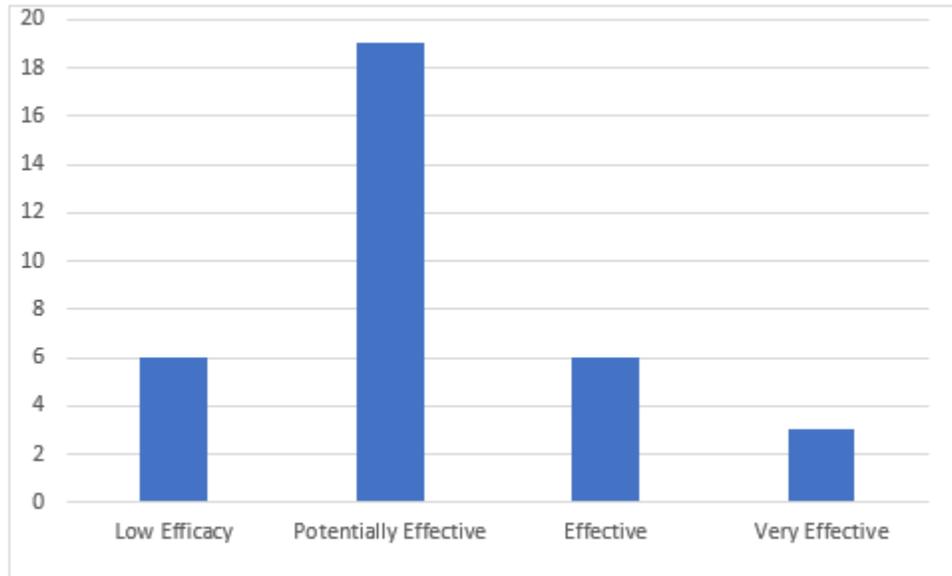
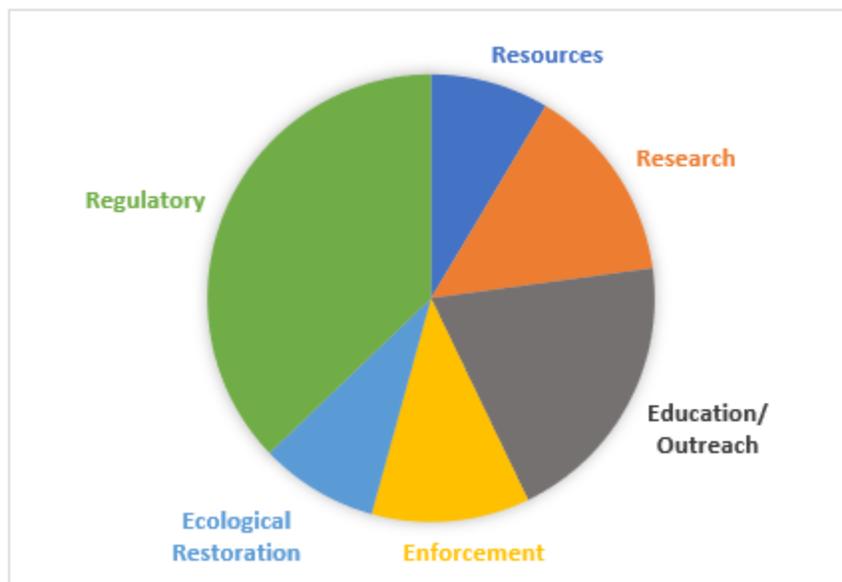


Figure 3: Strategy Categories



Methods Used to Assess Strategies

Effectiveness Calculations

Commission staff assessed the effectiveness of all strategies that were proposed by the three stakeholder groups. After eliminating duplicate strategies, staff used the many discussions and understandings from stakeholder groups to evaluate how successful a strategy would be at achieving a particular goal. A strategy's goal(s) were identified through analysis of its "results chain," as either the primary means by which threats would be abated, or as "research" in the case of strategies designed to fill informational gaps.

Strategies are rated on two criteria, potential impact and feasibility.

Potential Impact

If implemented, will the strategy lead to desired changes in the situation?

- Very High - The strategy is very likely to completely mitigate a threat or restore a target.
- High - The strategy is likely to help mitigate a threat or restore a target.
- Medium - The strategy could possibly help mitigate a threat or restore a target.
- Low - The strategy will probably not contribute to meaningful threat mitigation or target restoration.

Note that at least two dimensions are combined into this rating: probability of positive impact and magnitude of change. The potential impact rating takes into account both of these factors, which were assessed in terms of the overall scope of the strategy. For example, a strategy which contemplates a localized biological effect would be evaluated in terms of the likelihood and magnitude of impact to a local area, and not penalized because it did not have a statewide scope.

Feasibility

Would implementation of the strategy be likely within biological, regulatory, time, financial, staffing, ethical, and other constraints?

- Very High - The strategy is ethically, technically, AND financially feasible.
- High - The strategy is ethically and technically feasible, but may require some additional financial resources.
- Medium - The strategy is ethically feasible, but either technically OR financially difficult without substantial additional resources.
- Low -The strategy is not ethically, technically, OR financially feasible.

Potential impact and feasibility are combined to give an overall summary effectiveness rating for the strategy, as illustrated in Table 2.

Table 2: Effectiveness Rating Calculation Matrix

		Potential Impact			
		Very High	High	Medium	Low
Feasibility	Very High	Very High	High	Medium	Low
	High	High	High	Medium	Low
	Medium	Medium	Medium	Medium	Low
	Low	Low	Low	Low	Low

Strategies are then classified as Very Effective (very high result), Effective (high result), Potentially Effective (medium result), or Low Efficacy (low result).

*Note that it is critical to understand that effectiveness is an attempt to rate strategies with respect to whether they will be successful, **not whether they are desirable**. Even a strategy with low efficacy may be desirable for particular reasons (for example, if it requires minimal investment to implement or fills a needed gap in strategy diversification). Effectiveness is an attempt to rate the ability of a strategy to accomplish specific goals in addressing extant threats to natural and human well-being targets. Desirability — the decision whether or not to implement a given strategy — is usually informed by effectiveness, but it is ultimately a value judgment whether or not to move forward with a particular solution.*

Categorization

Commission staff placed each strategy into one of six general categories, representing the strategy’s primary mode of action: Resources, research, education and outreach, ecological restoration, regulatory actions, and enforcement actions.

Resources

All strategies will require some level of resources to implement (e.g., financial, temporal, staffing). The amount and type necessary to achieve a given strategy will depend on a number of factors, including the specific portfolio of projects to be implemented within a strategy, the ability to capitalize on already available resources, and the formation of strategic partnerships, to name but a few. Assessing the resources necessary to implement particular strategies is an important consideration, but is beyond the scope of the stakeholder inquiry; while the expertise of stakeholders is extensive, even as a group they do not possess an overview of available resources within various partner organizations that may be involved in implementation: state governments, local governments, non-governmental organizations, trade and industry groups, businesses, research institutions, etc.

Research

The stakeholder engagement process identified several important knowledge gaps. Many of the informational needs are critical to properly assess the scope of particular issues, the biological dynamics at play and relative risk caused by various ecological threats, and the overall effectiveness of strategies.

Education and Outreach

All stakeholder groups identified educational campaigns as an important initiative. Potential audiences identified included live market retailers, pet owners and retailers, teachers, aquaculture facilities, and importers; key themes and messages would vary according to the particular audience.

Stakeholders identified several existing educational programs that could be adopted or serve as partners to achieve educational goals. Alternatively, one or more of the programs could serve as models from which to develop proprietary education initiatives.

Ecological Restoration

Direct action in the environment will be an important component of any comprehensive solution. Direct action could include strategies such as habitat improvement for native species threatened by non-native turtles and bullfrogs, or localized eradication initiatives; these strategies are typically resource intensive, requiring a great deal of time, planning, and funding to execute properly. However, they have been shown to be successful in many cases.

Regulatory Actions

The Commission promulgates regulations concerning wildlife in the State of California, consistent with the California Fish and Game Code. Stakeholders offered many strategies that would require legislative and/or regulatory changes to implement. Evaluating the effectiveness of these strategies necessarily involved the likelihood of rule changes actually being implemented; particularly in the case of legislative changes, this involved a value judgment.

Enforcement Actions

Stakeholders generally agree that bullfrog- and turtle-related enforcement actions are not predominant in California. There are differing opinions on whether increased enforcement is necessary, where those actions should focus, how to accomplish obtaining more resources for the Department's enforcement efforts, and how effective increased enforcement actions would be in alleviating some of the threats to California's native wildlife.

Recommendation Ranks

Commission staff recommendations are ranked on a scale of 1 to 5:

- 1 = "not recommended"
- 2 = "probably not recommended"
- 3 = "recommended if willing to accept some drawbacks and/or disadvantages"
- 4 = "recommended"
- 5 = "highly recommended"

Note that recommendation ranks for individual strategies refer to implementation of the single strategy alone. Recommendations for strategies may change when combined with other strategies (see section on ***Strategy Bundles***).

Strategy Analyses and Recommendations

Some strategies are relatively independent, while others are more dependent on, or synergistic with, other strategies. In addition to considering strategies one-by-one, this analysis provides a representative sampling of strategy combinations (“bundles”). Not all viable permutations are represented, as the number of possible arrangements is massive. Therefore, the Commission Wildlife Resources Committee may recommend strategy bundles that are not considered here.

Individual Strategies

Strategy 1: More Resources for DFW

Procure more budgetary resources for the Department, either directly from the California State Legislature or through a special program, such as voluntary income tax contributions.

Category	Effectiveness	Level of Controversy	Key Actors
Resources	Effective	Low	Leg, DFW

Primary Goals: Increase resources for implementation

Potential Impact: Very High

Feasibility: High

Recommendation rank: 5

This option is a necessity to implement any strategy which the Department cannot absorb in existing budgets and initiatives. Essentially, any strategy that is not solely regulatory in nature will require additional resources to implement, and even solely regulatory actions can have budget implications for management activities, such as outreach, education and enforcement.

Strategy 2: Raise Permit Prices

Raise the cost of importation permits and apply the funds to other strategies.

Category	Effectiveness	Level of Controversy	Key Actors
Resources	Potentially Effective	Medium	DFW, Commission?

Primary Goals: Increase resources for implementation

Potential Impact: Medium

Feasibility: High

Recommendation rank: 5

This strategy would produce more resources for the Department, but raising importation permit prices substantially while keeping imports economical may not be possible. Additionally, this strategy is not compatible with some other strategies, such as import bans.

Strategy 3: Department Grant Program

Establish a new grant program for DFW to disburse funds for various bullfrog and non-native turtle projects.

Category	Effectiveness	Level of Controversy	Key Actors
Resources	Potentially Effective	Low	DFW, Leg

Primary Goals: Increase resources for implementation

Potential Impact: High

Feasibility: Medium

Recommendation rank: 4

If a stable funding source for bullfrog and non-native turtle-related grants can be established, it could serve as a springboard for the implementation of innovative projects that could not or would not otherwise be attempted, serve to highlight the subject as an important issue needing attention, answer important research questions, and funnel resources to organizations that may be able to supplement Department and Commission initiatives. This would likely require specific funding from the Legislature.

Strategy 4: Research into Release "Inputs"

Gain more information about escapees and intentional releases from live markets and pets.

Category	Effectiveness	Level of Controversy	Key Actors
Research	Very Effective	Low	DFW, Fed

Primary Goals: Research

Potential Impact: Very High

Feasibility: Very High

Recommendation Rank: 5

These are critical knowledge gaps. This research would help resolve many uncertainties about the dynamics at play and the effectiveness of other strategies.

Strategy 5: Research on Discharge

Gain more information about water used for transport and storage, including disease pathogens, invasive aquatic organisms, and water treatment methods.

Category	Effectiveness	Level of Controversy	Key Actors
Research	Potentially Effective	Low	DFW, Fed

Primary Goals: Research

Potential Impact: Medium

Feasibility: High

Recommendation Rank: 3

The research would fill in knowledge gaps with respect to contaminated runoff water, but contaminated water may not be a very significant threat.

Strategy 6: Research into Live Food as Vectors for Diseases

Gain more information about the prevalence, epidemiology, and treatment of frog- and turtle-borne diseases in the live markets.

Category	Effectiveness	Level of Controversy	Key Actors
Research	Very Effective	Low	DFW, Fed

Primary Goals: Research

Potential Impact: Very High

Feasibility: Very High

Recommendation Rank: 4

There has been some research on this topic, but many open questions remain. Answers may help lower the risks of new diseases entering California.

Chytrid fungus is nearly ubiquitous in California. Ranaviruses have a relatively low prevalence.

Strategy 7: Research into Population Control Techniques

Gain more information on eradication and control techniques, habitat enhancements to combat bullfrogs and non-native turtles, and other similar environmental interventions.

Category	Effectiveness	Level of Controversy	Key Actors
Research	Potentially Effective	Low	DFW, Fed

Primary Goals: Reduce the number of bullfrogs/turtles in the environment

Potential Impact: High

Feasibility: Medium

Recommendation Rank: 4

This strategy could provide valuable results but would require substantial new resources.

Strategy 8: Encourage Wild Collection

Promote collection of bullfrogs for personal food use as an alternative to purchase in live markets.

Category	Effectiveness	Level of Controversy	Key Actors
Education and Outreach	Potentially Effective	Low	DFW, Commission?

Primary Goals: Reduce the number of bullfrogs/turtles in the environment

Potential Impact: Medium

Feasibility: Very High

Recommendation rank: 3

While this strategy would likely have only positive benefits and a campaign would be relatively simple to employ, wild collection of frogs and turtles is unlikely to be popular enough to have much of an effect on wild invasive populations. The ultimate benefit of such a campaign will greatly depend on the resources necessary in order to significantly expand wild collection as a recreational activity and the audience's yet-to-be-determined receptivity.

Strategy 9: Bullfrogs as Bait

Promote the use of bullfrogs as bait for fishing.

Category	Effectiveness	Level of Controversy	Key Actors
Education and Outreach	Low Efficacy	Low	DFW

Primary Goals: Reduce the number of bullfrogs/turtles in the environment

Potential Impact: Low

Feasibility: Very High

Recommendation rank: 2

This strategy is easy to implement, but likely to have very limited impact. Angler reception to using bullfrogs is unknown, and bullfrog bait may be of limited use to anglers.

Strategy 10: Education Campaign 1 (Live Markets)

Establish a focused, periodic education initiative at live market vendors to instill best practices and reinforce existing regulations.

Category	Effectiveness	Level of Controversy	Key Actors
Education	Potentially Effective	Low	DFW, Public

Primary Goals: Reduce the number of bullfrogs/turtles in the environment. Curtail risks from diseases and/or introduction of new diseases

Potential Impact: Medium

Feasibility: High

Recommendation rank: 3

This strategy focuses on a key audience, but is not highly recommended in favor of a more comprehensive campaign.

Strategy 11: Education Campaign 2 (Pets)

Establish a sustained education campaign aimed at pet owners, retailers, and other relevant audiences to instill the importance of not releasing animals into the wild. Teach good animal care techniques to lessen the impetus to abandon pets.

Category	Effectiveness	Level of Controversy	Key Actors
Education	Potentially Effective	Low	DFW, Public

Primary Goals: Decrease introduction of new frogs/turtles into environment

Potential Impact: Medium

Feasibility: High

Recommendation rank: 3

This strategy focuses on a key audience, but is not highly recommended in favor of a more comprehensive campaign.

Strategy 12: Education Campaign 3 (All-Encompassing)

Establish a comprehensive education campaign, or a series of campaigns, to address many different audiences and issues.

Category	Effectiveness	Level of Controversy	Key Actors
Education	Very Effective	Low	DFW, Public

Primary Goals: Curtail risks from diseases and/or introduction of new diseases. Decrease introduction of new frogs/turtles into environment.

Potential Impact: Very High

Feasibility: Very High

Recommendation rank: 4

While different lessons for different audiences can be developed, significant gains (non-duplication of effort, etc.) may be realized from a single educational campaign.

Some models for parts of such a campaign already exist. Clean Drain Dry and Stop AIS (aquatic invasive species) are potential models for good education campaigns regarding the proliferation of non-native aquatic organisms. They have had positive impacts.

Habitattitude is a PIJAC partnership with the U.S. Fish and Wildlife Service and the National Oceanic and Atmospheric Administration with a wide audience including water gardeners, students, and teachers. Key messages include: don't release pets into the wild, move things up the consumer timeline, be aware of all that comes into play when owning a pet. It is composed of partnerships with organizations that share the message. It is mostly on the web.

Strategy 13: Increased Compliance with Animal Release Regulations

Education initiative aimed primarily at reducing intentional releases, including live market, unwanted pets, and other wildlife releases. One potential audience is local and county officials, to encourage the development of local ordinances which may play a role in reinforcing state regulations against releases as well.

Category	Effectiveness	Level of Controversy	Key Actors
Enforcement	Potentially Effective	Low	DFW

Primary Goals: Decrease introduction of new frogs/turtles into environment

Potential Impact: Medium

Feasibility: High

Recommendation rank: 3

Requires the cooperation of local municipalities to enact and enforce ordinances. As most animal releases happen in secret, enforcement is likely impossible to administer.

Strategy 14: Habitat Improvement

Implement restoration projects to improve conditions for various native species to allow them to better deal with the threats posed by bullfrogs and non-native turtles.

Category	Effectiveness	Level of Controversy	Key Actors
Ecological Restoration	Potentially Effective	Low	DFW

Primary Goals: Improve conditions for native species

Potential Impact: High

Feasibility: Medium

Recommendation rank: 4

Bullfrogs and non-native turtles are prolific in fragmented habitats. Habitat improvements could include creating base habitat conditions that favor native species and disfavor bullfrogs, promoting favorable water temperatures (e.g., colder water), promoting running water, reestablishing food webs, and/or eliminating barriers between native populations. These types of restoration initiatives are already part of the Department’s activities and priorities. The degree to which ongoing activities could account for bullfrogs and non-native turtles is unclear, but strengthening imperiled and sensitive populations may prove to be a powerful way to increase their resilience against invasive species.

Strategy 15: Localized Eradication

Implement focused, on-the-ground projects to eradicate bullfrogs from specific locations. This would likely be prioritized in areas with both sensitive species and ecological characteristics to support success.

Category	Effectiveness	Level of Controversy	Key Actors
Ecological Restoration	Effective	Low	DFW

Primary Goals: Reduce the number of bullfrogs/turtles in the environment

Potential Impact: Very High

Feasibility: High

Recommendation rank: 5

In selected circumstances, eradication of bullfrogs has been shown to be achievable (it is unclear whether the same is true for non-native turtles). Other strategies short of eradication, such as invasive population reductions or limited control efforts, have also been shown to be effective at reducing competition and increasing the fitness of native populations. Limited eradication generally requires specific ecological and landscape conditions for success. This strategy could require substantial resources to plan and implement.

Strategy 16: Use of Private Land Eradication of Fish

Existing authorities allow the Department to cooperate with private landowners to eradicate invasive and harmful fish, which includes bullfrogs.

Strategy	Effectiveness	Level of Controversy	Key Actors
Ecological Restoration	Effective	Low	Leg?, Commission, DFW, Private

Primary Goals: Reduce the number of bullfrogs/turtles in the environment

Potential Impact: High

Feasibility: High

Recommendation rank: 5

In addition to general authorities granted to the Department under Fish and Game Code Section 6855 for the control of nuisance frogs, California Code of Regulations Title 14, Sections 226.5 outlines a framework for the control of fish (which would include frogs) that are harmful to other species of fish. These authorities may provide a means for controlling bullfrogs on private lands, in cooperation with willing landowners.

Regulatory action may be required to permit more effective techniques (i.e., gigging). Legislative and/or regulatory action may also be required to allow eradication of non-native turtles, as they are not classified as fish for the purposes of this activity. These types of restoration projects have a track record of success. With cooperative landowners, this strategy could extend the Department's eradication reach onto private lands.

Strategy 17: Ban Sale of Live Bullfrogs

Sale of live bullfrogs would be illegal, but dead (e.g., frozen) bullfrogs could still be sold.

Category	Effectiveness	Level of Controversy	Key Actors
Regulatory	Effective	High	Commission

Primary Goals: Curtail risks from diseases and/or introduction of new diseases. Decrease introduction of new frogs/turtles into environment

Potential Impact: High

Feasibility: High

Recommendation rank: 3

While this strategy may curtail disease propagation through live markets, current customers would likely see non-live bullfrogs as inedible, effectively closing the markets down, which may lead to black markets. The potential disease introduction risk from live markets – primarily that of new strains of existing diseases and novel diseases – is currently not well understood.

Strategy 18: Point of Sale Inspections

Department personnel would perform inspections on live markets to ensure compliance with state regulations.

Strategy	Effectiveness	Level of Controversy	Key Actors
Enforcement	Potentially Effective	Medium	DFW

Primary Goals: Curtail risks from diseases and/or introduction of new diseases. Curtail risks from invasive aquatic species and/or introduction of new invasive aquatic species. Decrease introduction of new frogs/turtles into environment

Potential Impact: Medium

Feasibility: Medium

Recommendation rank: 4

Posters are passed out in and hung in live markets, explaining in native languages that “Releasing live turtles or frogs is prohibited” and listing the CALTIP line for reporting violations. The Department has informed merchants that they must post the signs where live animals are sold for food.

Inspections may help curtail live markets as a vector for the introduction of invasive aquatic organisms. Inspections would also help with regulatory compliance but may be looked upon with skepticism and suspicion by live marketeers. This strategy would likely require more resources for Department enforcement.

Strategy 19: Domestic Bullfrog/Turtle Aquaculture

In the event of a loss of extra-state bullfrog importation (presumably through regulation), domestic aquaculture facilities could establish a market supply. ***This approach likely cannot be implemented as a stand-alone strategy.***

Category	Effectiveness	Level of Controversy	Key Actors
Regulatory	Potentially Effective	Low	Commission, DFW, Private

Primary Goals: Maintain market sales

Potential Impact: Medium

Feasibility: High

Recommendation rank: 3

For current aquaculture facilities, bullfrogs are a negligible business consideration. Bullfrogs are ubiquitous; they are frequently caught in on-site nets and are a typical byproduct. Turtles are a very rare occurrence.

The viability of an aquaculture industry will greatly depend on favorable market conditions. Price per frog would be an important factor in making California bullfrog or turtle aquaculture a viable business, and therefore such an endeavor would be unlikely to succeed unless a market was guaranteed through the imposition of an import ban. However, there do not appear to be any regulatory barriers to aquaculture – bullfrogs could be recognized as a legitimate aquaculture product now.

With respect to disease, initially, bullfrog farms may have the same disease prevalence as the environment, but that could change depending on innovation and advances in culture practices, site treatments, etc. Domestic aquaculture would afford greater monitoring opportunities of market animal disease loads. The key environmental benefit would be the curtailing of new disease, or new strains of extant diseases, through an import ban; aquaculture would simply allow market sales to continue alongside the implementation of that strategy.

Strategy 20: Testing and Monitoring Regime

Develop and implement a protocol for sampling animals for sale at live markets for various diseases and/or invasive aquatic organisms.

Category	Effectiveness	Level of Controversy	Key Actors
Research	Potentially Effective	High	DFW

Primary Goals: Curtail risks from diseases and/or introduction of new diseases; Curtail risks from invasive aquatic species and/or introduction of new invasive aquatic species

Potential Impact: Medium

Feasibility: Medium

Recommendation rank: 4

Monitoring may not reveal much more than that disease is fairly ubiquitous among imported animals. Still, this strategy may provide valuable insights on its true prevalence and ways to combat the introduction of disease. Surveillance may detect new strains or new diseases before becoming widespread in California, and an understanding of inadvertent import of aquatic organisms, about which little is known. This strategy may be viewed as intrusive by importers and retailers and would require substantial new resources for the Department.

Strategy 21: Increased Information Collection through Permits

Revise importation permits to gather more *information* that may be useful, such as: Where are shipments coming from? How many shipments/individuals are you bringing in under this permit? Do you have permission from the source?

Category	Effectiveness	Level of Controversy	Key Actors
Regulatory	Low Efficacy	Low	DFW, Commission

Primary Goals: Curtail risks from diseases and/or introduction of new diseases

Potential Impact: Low

Feasibility: High

Recommendation rank: 2

Importers likely do not have exact numbers of imported individuals, other than extrapolating from the number of shipments. While relatively simple to enact, it is unclear how more information would be useful to achieve relevant goals.

Strategy 22: Promotion of Programs for Unwanted Animals

Implement and support places, such as sanctuaries, for pets and companion animals to be taken and kept when they are unwanted or unable to be cared for. Also includes “rehoming” organizations.

Category	Effectiveness	Level of Controversy	Key Actors
Education	Low Efficacy	Low	DFW, Public

Primary Goals: Decrease introduction of new frogs/turtles into environment

Potential Impact: Low

Feasibility: Medium

Recommendation rank: 2

Some programs exist but have limited capacity and effectiveness. Creating new facilities may temporarily alleviate some releases, but total needed capacity is likely enormous. Turtles in particular are long-lived and can require extensive resources to house. “Rehoming” initiatives may work but, again, have limited capacity. However, this strategy may gain traction when bundled with other strategies.

Strategy 23: Dispatching bullfrogs in contests

In jumping frog contests, terminate all bullfrogs that are not being kept by contestants.

Category	Effectiveness	Level of Controversy	Key Actors
Regulatory	Effective	High	Commission, DFW

Primary Goals: Decrease introduction of new frogs/turtles into environment

Potential Impact: High

Feasibility: Very High

Recommendation rank: 4

While some groups may see this as controversial, this would largely eliminate contests as vectors for disease and released individuals.

Strategy 24: Ban Frog Jumping Contests

Frog jumping contests would be outlawed through regulation.

Category	Effectiveness	Level of Controversy	Key Actors
Regulatory	Low Efficacy	High	Leg, Commission?

Primary Goals: Decrease introduction of new frogs/turtles into environment

Potential Impact: High

Feasibility: Low

Recommendation rank: 1

This strategy would require legislative repeals of current Fish and Game Code sections and would prohibit a popular recreational activity. The true significance of frog jumping contests as a vector for disease is unknown, and this strategy may be too extreme given the actual risk. Other strategies related to frog jumping contests could have significant enough impacts without an outright ban.

Strategy 25: Contest Monitoring/Enforcement

Deploy monitors to frog jumping contests to help guard against escapees and ensure compliance with state regulations.

Category	Effectiveness	Level of Controversy	Key Actors
Enforcement	Potentially Effective	Medium	DFW

Primary Goals: Decrease introduction of new frogs/turtles into environment

Potential Impact: Medium

Feasibility: Medium

Recommendation rank: 3

Frogs can be bought from authorized sellers, caught in the wild, or rented. Rented frogs are likely collected and then released (staff has not yet confirmed this statement). Events have a minimum size limit to avoid other non-native frogs.

The effectiveness of monitoring of contests for compliance with current regulations would have unclear benefits and would require substantial resources to implement. However, when paired with certain other strategies, this strategy could be an important factor in success.

Strategy 26: Encourage/Allow Use of Other Species with Lesser Effects

Disallow or discourage the use of bullfrogs in jumping contests, in favor of utilizing other species.

Category	Effectiveness	Level of Controversy	Key Actors
Education and Outreach (or Regulatory)	Potentially Effective	High	DFW, Commission, Leg?

Primary Goals: Reduce the number of bullfrogs/turtles in the environment

Potential Impact: Medium

Feasibility: Medium

Recommendation rank: 1

This option could also be implemented as a regulatory mandate rather than simple encouragement, though the legality of such a regulation is yet to be determined. Encouraging the use of native species in jumping contests could have negative effects for those species, such as encouraging aggressive collection of declining or sensitive species and substantially reducing populations in local areas. Contest participants would likely object, since bullfrogs are prized for their jumping prowess.

Strategy 27: Water & reservoir management

Encourage municipalities to enact ordinances to protect against bullfrogs and non-native turtles, and to manage their water features to enhance suitability for native species.

Strategy	Effectiveness	Level of Controversy	Key Actors
Regulatory	Potentially Effective	Medium	DFW, Localities, Private

Primary Goals: Decrease introduction of new frogs/turtles into environment

Potential Impact: Medium

Feasibility: High

Recommendation rank: 4

Regulatory reforms at and near water structures could have significant effects on localized bullfrog populations, as evidenced by areas where such reforms have been implemented; however, they require the cooperation of local and county officials. The Department, in partnership with successful localities, could encourage other facilities to implement rules to limit the spread and effects of bullfrogs and non-native turtles.

Strategy 28: Ban Bullfrog Imports

Enaction of a complete ban on any bullfrogs or bullfrog parts, living or dead, shipped from any source outside of California.

Category	Effectiveness	Level of Controversy	Key Actors
Regulatory	Effective	High	Commission

Primary Goals: Curtail risks from diseases and/or introduction of new diseases

Potential Impact: High

Feasibility: High

Recommendation rank: 3

There are few small importers left in the state. This strategy would effectively close down live markets with no mitigating strategies to keep them open; businesses that solely import bullfrogs would be eliminated. Suppliers may not be able to switch to in-state sources, even if those sources were established. A ban may encourage a black market and/or importation of unregulated animals. However, the strategy would be effective in eliminating live markets as a vector for new diseases and new strains of extant diseases. Asian communities would lose a cultural food source.

Strategy 29: Develop Commercial Harvesting

Allow and develop a market for the commercial harvest of bullfrogs and/or non-native turtles, to supplement (or supply, in the case of some type of import ban) animals for the live markets.

Category	Effectiveness	Level of Controversy	Key Actors
Regulatory	Potentially Effective	Medium	Commission, DFW, Private

Primary Goals: Reduce the number of bullfrogs/turtles in the environment

Potential Impact: Medium

Feasibility: High

Recommendation rank: 2

As with all commercial harvest of non-native species, there is a risk of inducing illegal production or of encouraging proliferation of the species. Implemented alone, this strategy likely would remove some number of bullfrogs and/or turtles from the environment, but the benefits from establishing markets for harvested animals likely does not outweigh the substantial risks of creating incentives to increase the presence of non-natives in the environment.

Strategy 30: Add Non-Native Turtles to Restricted Species List

Promulgate a regulation to make it unlawful to import, transport, possess, or release alive selected non-native turtle species under normal circumstances.

Category	Effectiveness	Level of Controversy	Key Actors
Regulatory	Low Efficacy	High	Commission

Primary Goals: Curtail risks from diseases and/or introduction of new diseases. Decrease introduction of new frogs/turtles into environment.

Potential Impact: High

Feasibility: Low

Recommendation rank: 1

The restricted species list bans importation, transport, and possession of certain species. Import bans can be achieved by other regulatory means, and prohibition of transport and possession of non-native turtles is overly restrictive.

Strategy 31: Add Bullfrogs to Restricted Species List

Promulgate a regulation to make it unlawful to import, transport, possess, or release alive bullfrogs under normal circumstances.

Category	Effectiveness	Level of Controversy	Key Actors
Regulatory	Low Efficacy	High	Commission

Primary Goals: Curtail risks from diseases and/or introduction of new diseases. Decrease introduction of new frogs/turtles into environment

Potential Impact: High

Feasibility: Low

Recommendation rank: 1

The restricted species list bans importation, transport, and possession of certain species. Import bans can be achieved by other regulatory means, and prohibition of transport and possession of bullfrogs is overly restrictive.

Strategy 32: Prevent Water Contamination

Implement water treatment to prevent disease and/or invasive aquatic organisms from entering the environment.

Category	Effectiveness	Level of Controversy	Key Actors
Regulatory	Potentially Effective	Low	Commission

Primary Goals: Curtail risks from diseases and/or introduction of new diseases

Potential Impact: Medium

Feasibility: Medium

Recommendation rank: 4

Could be required for any or all of the following: import shipments, pet stores, market facilities, water from frogs or turtles in homes, and classrooms.

Most water likely goes down a municipal drain and receives standard water treatment, but that may or may not be completely effective. A regulation may prevent the introduction of new diseases or new strains of extant diseases. There are readily available, inexpensive, effective treatments that are easy to use.

Strategy 33: Ensure Shipments are Lawfully Obtained

Perform inspections to ensure that shipments have a valid chain-of-custody, valid health certificates when necessary, and other documentation as needed.

Category	Effectiveness	Level of Controversy	Key Actors
Regulatory	Potentially Effective	Low	DFW

Primary Goals: Curtail risks from diseases and/or introduction of new diseases

Potential Impact: Medium

Feasibility: Medium

Recommendation rank: 3

Most bullfrog imports originate from Taiwan; importers typically obtain two primary certifications; one from the Taiwanese Health Department indicating the bullfrogs are free from diseases, and another from the Taiwanese Department of Commerce attesting to the legitimacy of the company. Most non-native turtle imports are likely from domestic sources. It is unclear to what degree, if any, shipments are not consistent with existing regulations.

Strategy 34: Inspect Shipments for Illegal Imports/Mixing Species

Imported shipments would be subject to spot testing and/or inspections for diseases and invasive aquatic organisms.

Category	Effectiveness	Level of Controversy	Key Actors
Enforcement	Potentially Effective	Low	DFW

Primary Goals: Curtail risks from diseases and/or introduction of new diseases. Curtail risks from invasive aquatic species and/or introduction of new invasive aquatic species.

Potential Impact: Medium

Feasibility: Medium

Recommendation rank: 4

This strategy would require substantial resources for the Department to implement. Disease monitoring would be possible but likely not instantaneous, and live animal shipments could not ethically be delayed if test results would require an inordinate amount of time. However, the information gained on the types and prevalence of diseases and invasives being imported would be valuable and could prompt further measures to curtail their ingress.

Turtles are imported from a number of small and large sources, but most are from commercial facilities in Louisiana or Arkansas. The health standards for imports rest largely on the regulations (and thoroughness of regulatory enforcement) from the originating state.

Strategy Bundles

Many strategies may be better implemented together with other strategies. For example, strategies can reinforce each other, or the viability of one strategy may be dependent on the execution of another. This section incorporates draft recommendations for implementing “strategy bundles” – two or more strategies that may naturally fit together, creating a larger context for achieving a specific identified goal.

Live Markets

Bundle: Control disease and bullfrog introduction from live markets – Ban with Alternatives

Strategy	Effectiveness	Level of Controversy	Key Actors
Ban sale of live bullfrogs	Effective	High	Commission
Point of sale inspections	Potentially Effective	Medium	DFW
Encourage wild collection	Potentially Effective	Low	DFW, Commission?

Recommendation rank: 3

Mandating the sale of non-live bullfrogs would likely reduce that pathway as a vector for the introduction of new diseases. The effect of selling non-live bullfrogs on moderating diseases currently extant in California (e.g., ranaviruses, chytrid) is unknown, though introduction of new strains of the diseases would be reduced. Culturally, consuming fresh bullfrogs is important to Asian communities.

Bundle: Control disease introduction from live markets – Import Ban with Alternatives

Strategy	Effectiveness	Level of Controversy	Key Actors
Ban bullfrog imports	Effective	High	Commission
Develop commercial harvesting	Potentially Effective	Medium	Commission, DFW
Encourage wild collection	Potentially Effective	Low	DFW, Commission?

Recommendation rank: 2

Businesses that solely import bullfrogs would be eliminated. This bundle would continue the live markets, but the viability of supplanting current levels of imported bullfrogs with harvested animals is uncertain. Additionally, as with all commercial harvest of non-native species, there is a risk of inducing illegal production or of encouraging proliferation of the species; establishing markets for harvested animals can carry substantial risks of creating incentives to increase the presence of non-natives in the environment.

Bundle: Control disease introduction from live markets – Import Ban with Aquaculture

Strategy	Effectiveness	Level of Controversy	Key Actors
Ban bullfrog imports	Effective	High	Commission
Domestic bullfrog aquaculture	Potentially Effective	Low	Commission, DFW, Private

Recommendation rank: 3

Businesses that solely import bullfrogs would be eliminated. This bundle would continue live markets with an alternate source that may result in fewer diseased frogs, and would permit monitoring and regulation of facilities. The viability of an aquaculture industry will greatly depend on favorable market conditions.

Bundle: Control disease introduction from live markets – Research and Monitoring

Strategy	Effectiveness	Level of Controversy	Key Actors
Research into release “inputs”	Very Effective	Low	DFW, Fed
Research on discharge	Potentially Effective	Low	DFW, Fed
Research into live food as vectors for disease	Very Effective	Low	DFW, Fed
Testing and monitoring regime	Potentially Effective	High	DFW

Recommendation rank: 5

Implementing research initiatives and developing scientifically rigorous testing approaches would fill in key knowledge gaps, adding to our understanding of the pathways for disease and releases. The information would give insights on the effectiveness of other strategies where the efficacy is unclear.

Bundle: Control disease introduction through live markets – Point of Sale Reforms

Strategy	Effectiveness	Level of Controversy	Key Actors
Point of sale inspections	Potentially Effective	Medium	DFW
Prevent water contamination	Potentially Effective	Low	Commission

Recommendation rank: 4

These strategies are focused on testing and disease controls at the live markets. Water treatment protocols are likely an easy, cost-effective way to increase assurance of wastewater not serving as a vector for diseases and aquatic organisms.

Bundle: Shipping reforms

Strategy	Effectiveness	Level of Controversy	Key Actors
Raise permit prices	Potentially Effective	Medium	DFW, Commission?
Increase information collection through permits	Low Efficacy	Low	DFW, Commission
Prevent water contamination	Potentially Effective	Low	Commission
Ensure shipments are lawfully obtained	Potentially Effective	Low	DFW
Inspect shipments for illegal imports/mixing species	Potentially Effective	Low	DFW

Recommendation rank: 5

In the absence of an import ban, permit and shipping protocol reforms could serve to gain more resources for the Department and increase information. The efficacy of container inspections is unclear and should be examined in more depth.

Jumping Contests

Bundle: Control disease introduction from jumping contests

Strategy	Effectiveness	Level of Controversy	Key Actors
Dispatching bullfrogs in contests	Effective	High	Commission, DFW
Contest monitoring/enforcement	Potentially Effective	Medium	DFW

Recommendation rank: 4

While some groups may see this as controversial, these strategies would largely eliminate contests as vectors for disease and released individuals. Enforcement, while requiring additional resources for the Department, would increase the compliance and, therefore, the effectiveness of the strategy.

Ecological Strategies

Bundle: Direct biological intervention

Strategy	Effectiveness	Level of Controversy	Key Actors
Research into population control techniques	Potentially Effective	Low	DFW, Fed
Habitat improvement	Potentially Effective	Low	DFW
Localized eradication	Effective	Low	DFW
Use of private land eradication of fish	Effective	Low	Leg?, Commission, DFW, Private

Recommendation rank: 5

While generally localized in scope, on-the-ground restoration activities are likely the best way to reduce bullfrog and non-native turtle populations. These activities fit into existing DFW strategies and priorities. Better integration of bullfrog and non-native turtle considerations into decision-making processes for habitat improvement locations, as well as explicit consideration of bullfrogs and non-native turtles into restoration projects may improve outcomes. These types of restoration projects have a track record of success.

Bundle: Reduction of pet releases and disease

Strategy	Effectiveness	Level of Controversy	Key Actors
Increase compliance with animal release regulations	Potentially Effective	Low	DFW
Education campaign 2 (Pets)	Effective	Low	DFW, Public
Promotion of programs for unwanted animals	Low Efficacy	Low	DFW, Public
Prevent water contamination	Potentially Effective	Low	Commission

Recommendation rank: 4

These strategies are aimed at responsible pet ownership. While the efficacy of increased compliance with animal regulations and the promotion of unwanted animal programs may be in question, their effectiveness may be enhanced by a concurrent education initiative. Water cleansing protocols may also increase the source of pets as a vector for diseases and invasive aquatic organisms. The education campaign could be swapped with *Education Campaign 3 (All-Encompassing)*.

Bundle: Education Campaign 3 (All-Encompassing)

Strategy	Effectiveness	Level of Controversy	Key Actors
Education campaign 3 (All-Encompassing)	Very Effective	Low	DFW, Public
Promotion of programs for unwanted animals	Low Efficacy	Low	DFW, Public

Recommendation rank: 4

A comprehensive education campaign is likely the best option for education campaigns. While different lessons for different audiences can be developed, significant gains (nonduplication of effort, etc.) may be realized from a single educational campaign. The educational campaign may support the use of programs for unwanted animals, but existing programs are overutilized and under-supported and may not be able to handle large influxes of animals.

Appendix A

Raw Results from the Conservation Standards Work in the Bullfrog and Non-Native Turtle Stakeholder Engagement Process

This appendix presents, without interpretation or filtering, the results of the stakeholder engagement process for all three groups. The information is the result of the groups using the *Open Standards for the Practice of Conservation* to guide their analyses. More information on the Open Standards can be found at <https://conservationstandards.org/about/>.

Each stakeholder group formulated:

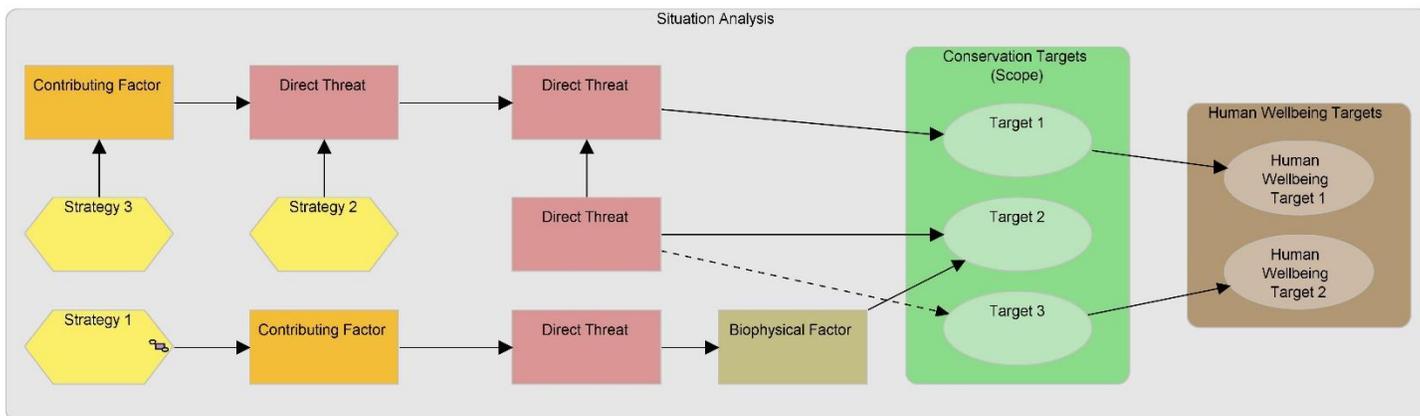
- a conceptual diagram which lays out conservation targets that experience some level of risk, the extant threats to those targets, and various strategies that may be implemented to address those threats;⁵
- “results chains” for all strategies that enumerate the stepwise, logical process by which those strategies may be expected to work; and
- notes that expand, clarify, and/or qualify certain elements of each assessment.

In addition, the agencies group elected to undergo a formal process to rank the proximate threats which they identified. A detailed explanation of outline how those assessments were developed precedes the rankings.

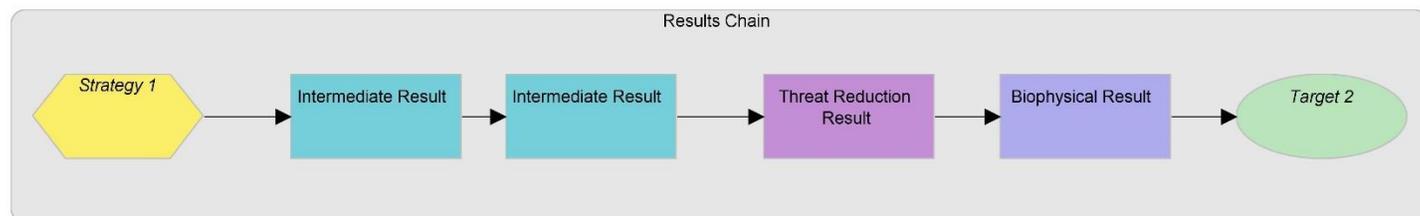
Notably, the situation analysis diagrams are not intended to depict every single factor at play, nor every relationship between those factors; rather, they are intended to highlight the most significant and meaningful associations that are relevant to understanding and achieving the vision enumerated by each group.

⁵ Inclusion of a particular strategy in a group’s analysis is not intended to indicate that the group favored or recommended it. Sometimes a particular strategy is intended as an alternative action, or perhaps simply to analyze the consequences of non-recommended strategies that may ultimately be implemented in the future. Indeed, certain strategies within a single analysis are mutually exclusive.

Sample Situation Analysis Diagram



Sample Results Chain Diagram



Note: During their assessments, the groups did not elect to use “biophysical factors” in the situation analysis diagrams or “biophysical results” in the results chain diagrams.

Guide to Symbols and Diagrams

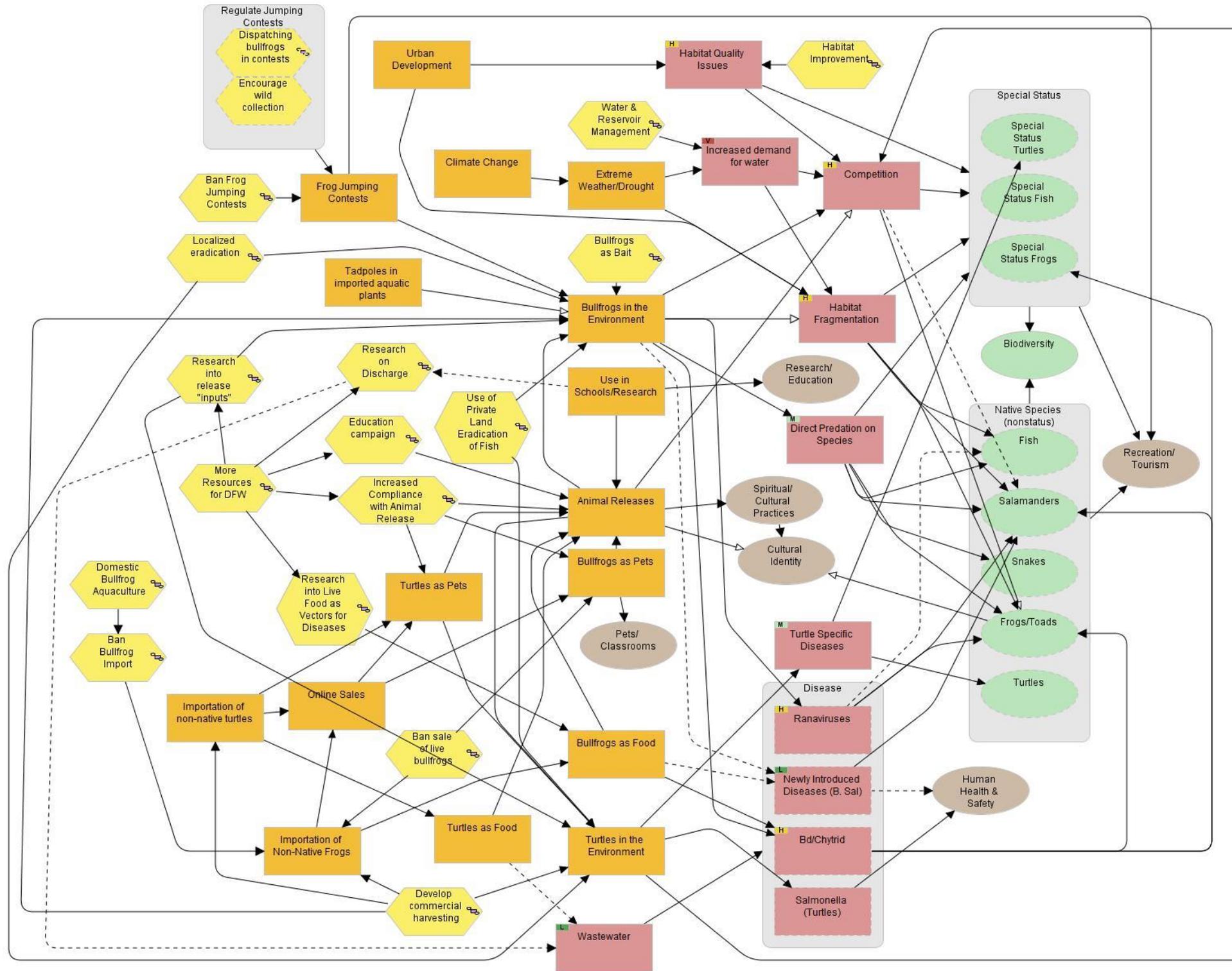
Symbol	Meaning
	Results chain
	Target
	Human Wellbeing Target
	Direct Threat
	Contributing Factor
	Intermediate Result
	Threat Reduction Result
	Strategy
	Text Box
	Group Box
	Causal Linkage
	Uncertain Link

Agency Group Analysis

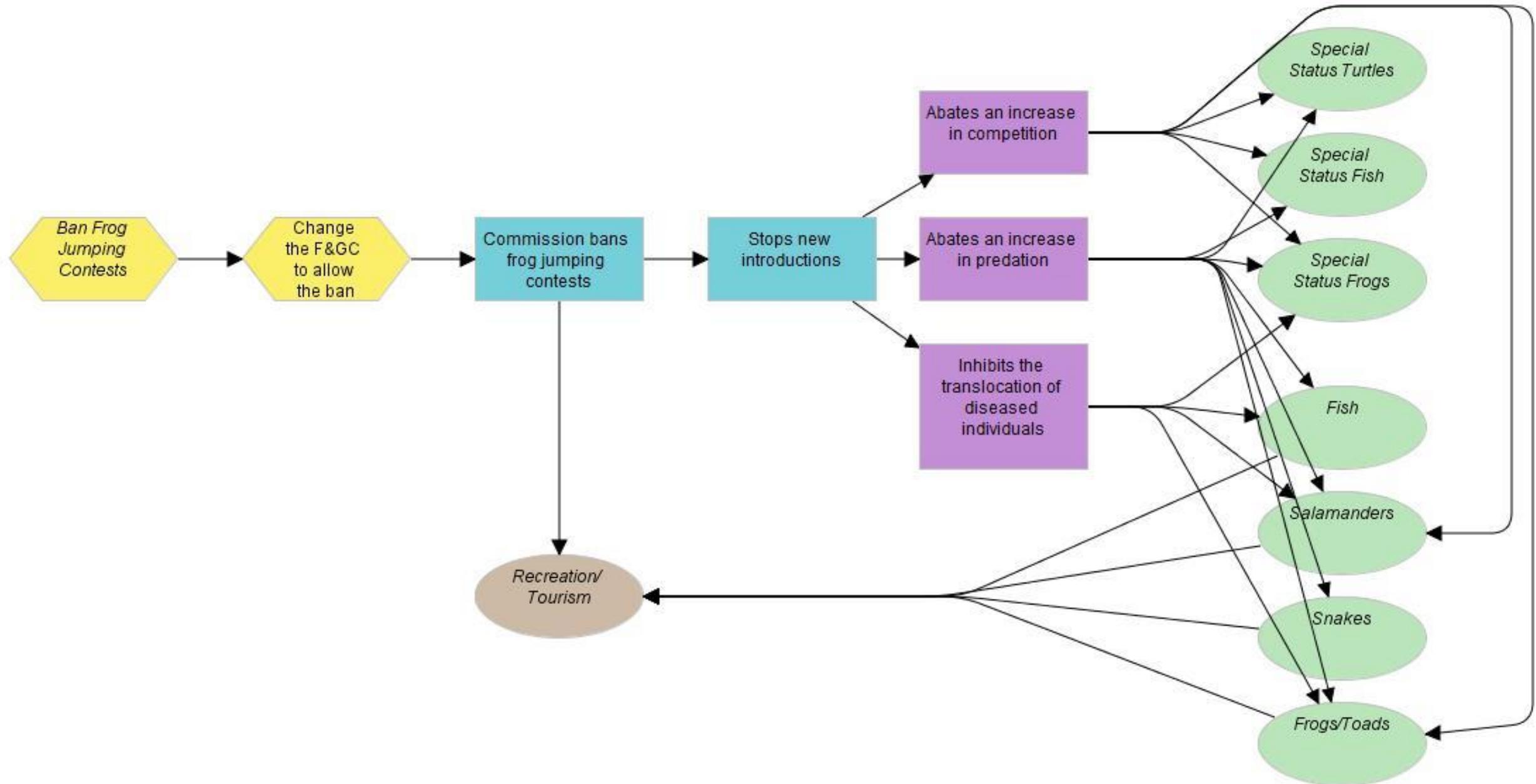
Scope and Vision

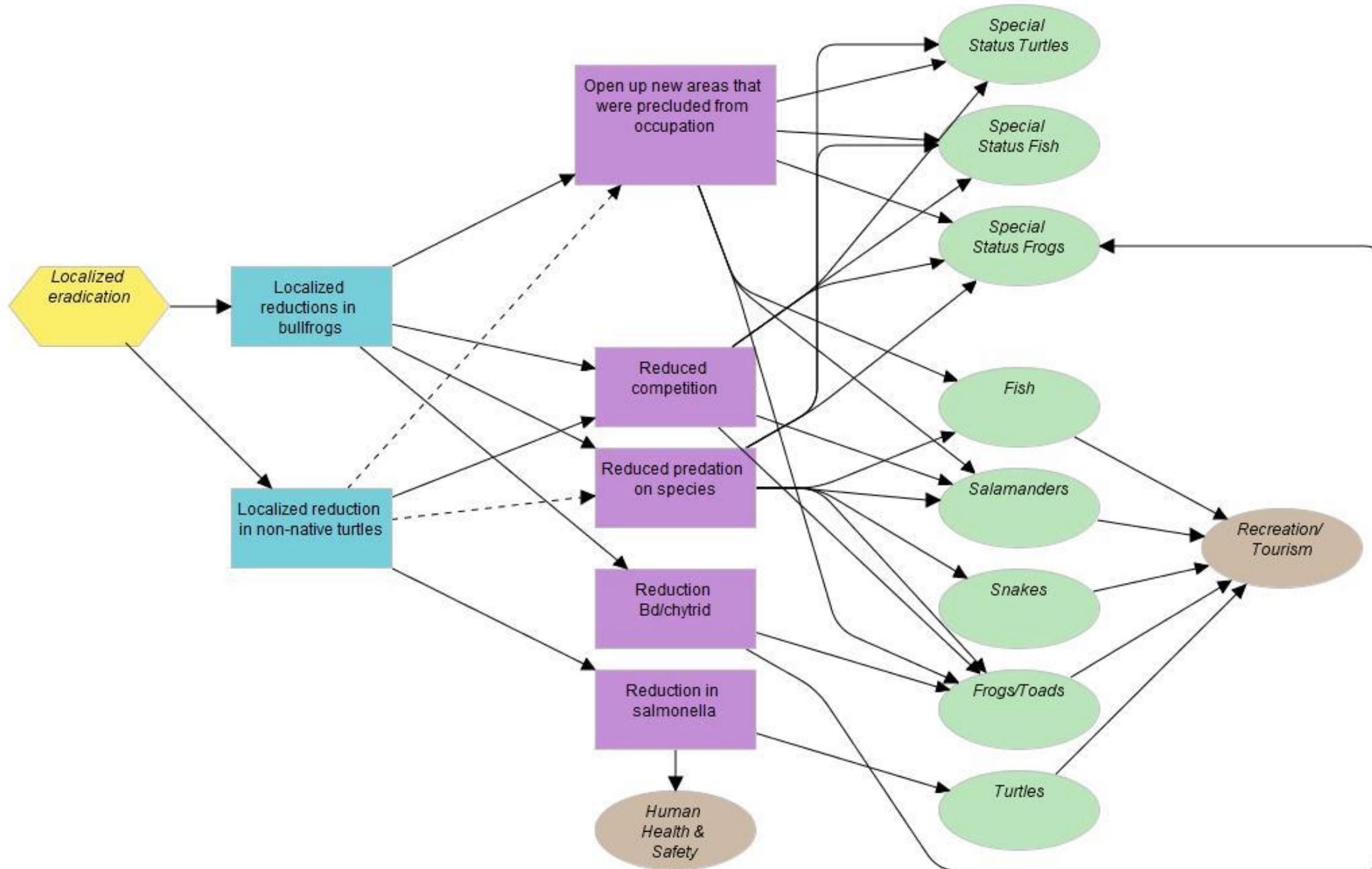
Scope/Site Name	Bullfrogs and non-native turtles in California
Vision Statement Text	To minimize the impacts to native species from bullfrog presence in California by managing, reducing, containing, controlling, regulating, and eventually eradicating them. Organizations should be provided the tools to limit populations and introductions.
Comments	There is a question as to whether or not eradication is feasible.

Main Diagram

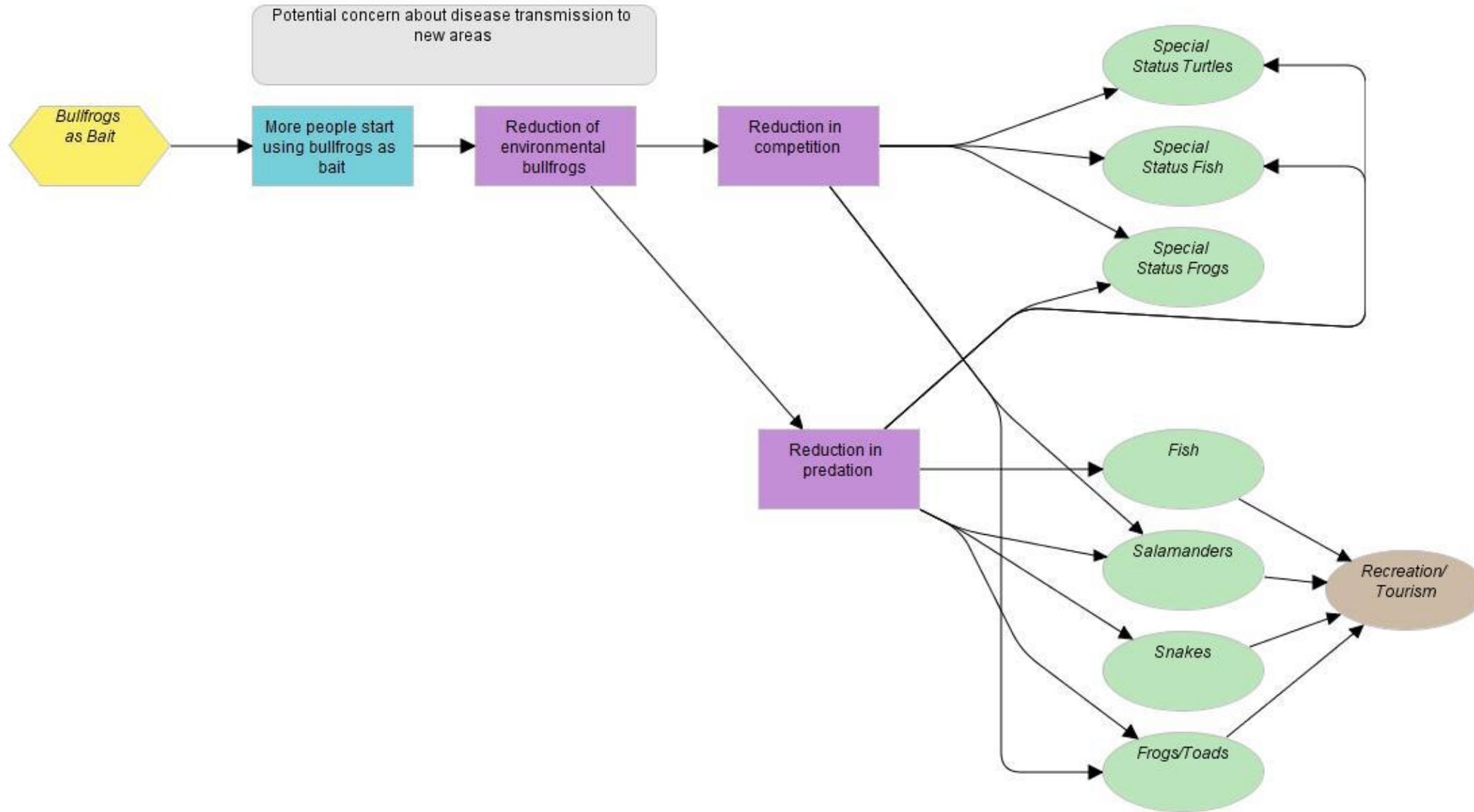


Results Chain: Ban frog jumping contests

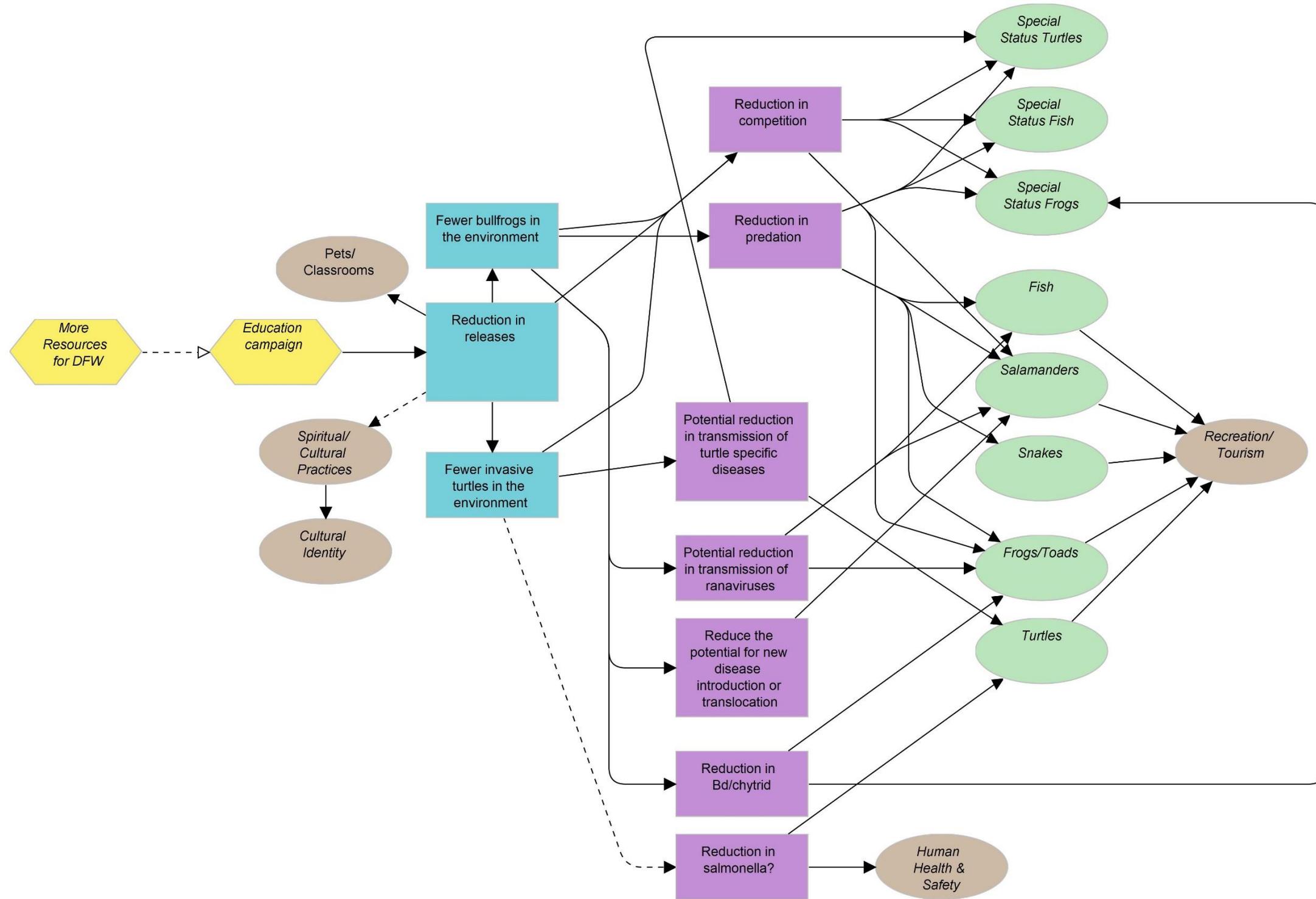




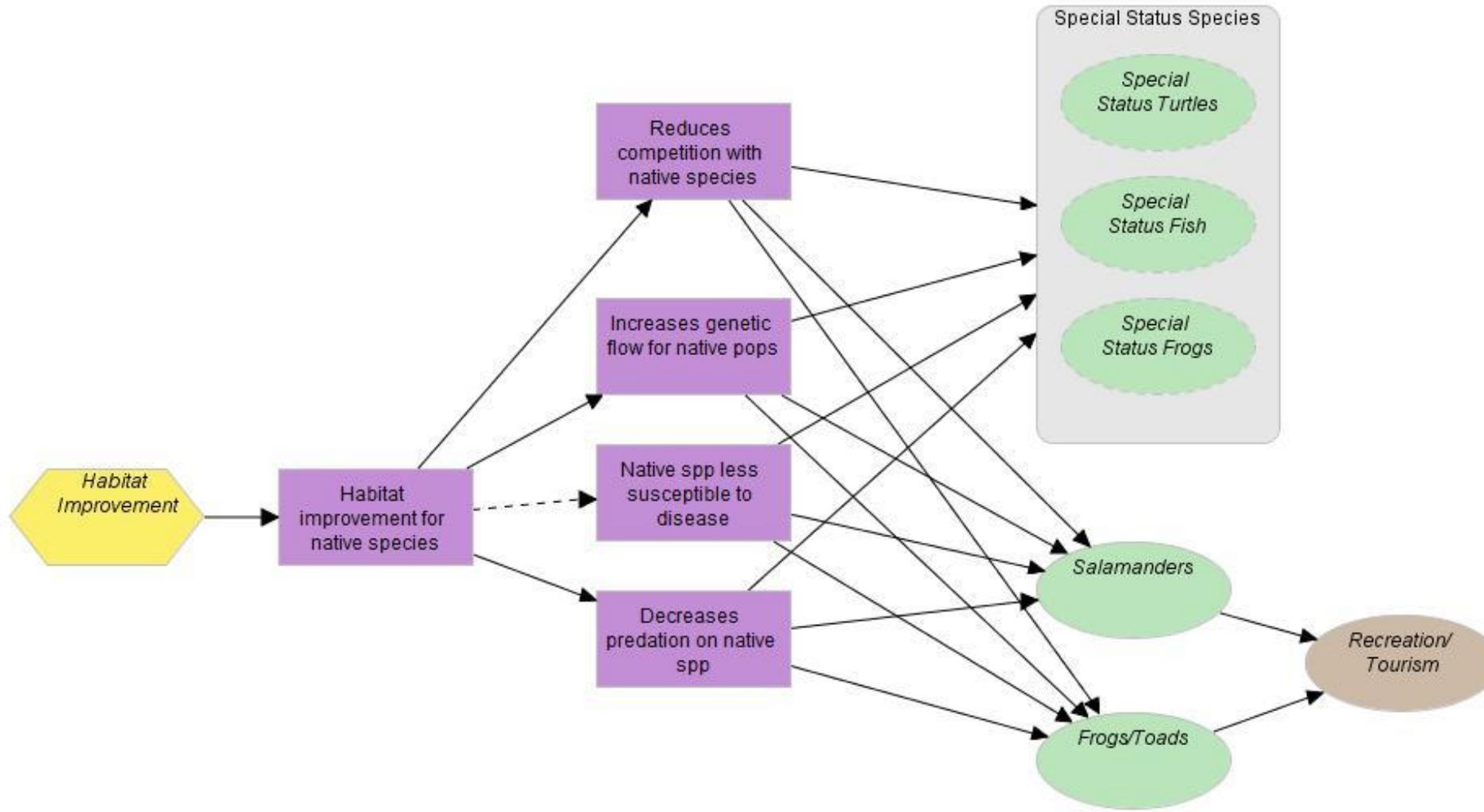
Results Chain: Bullfrogs as bait



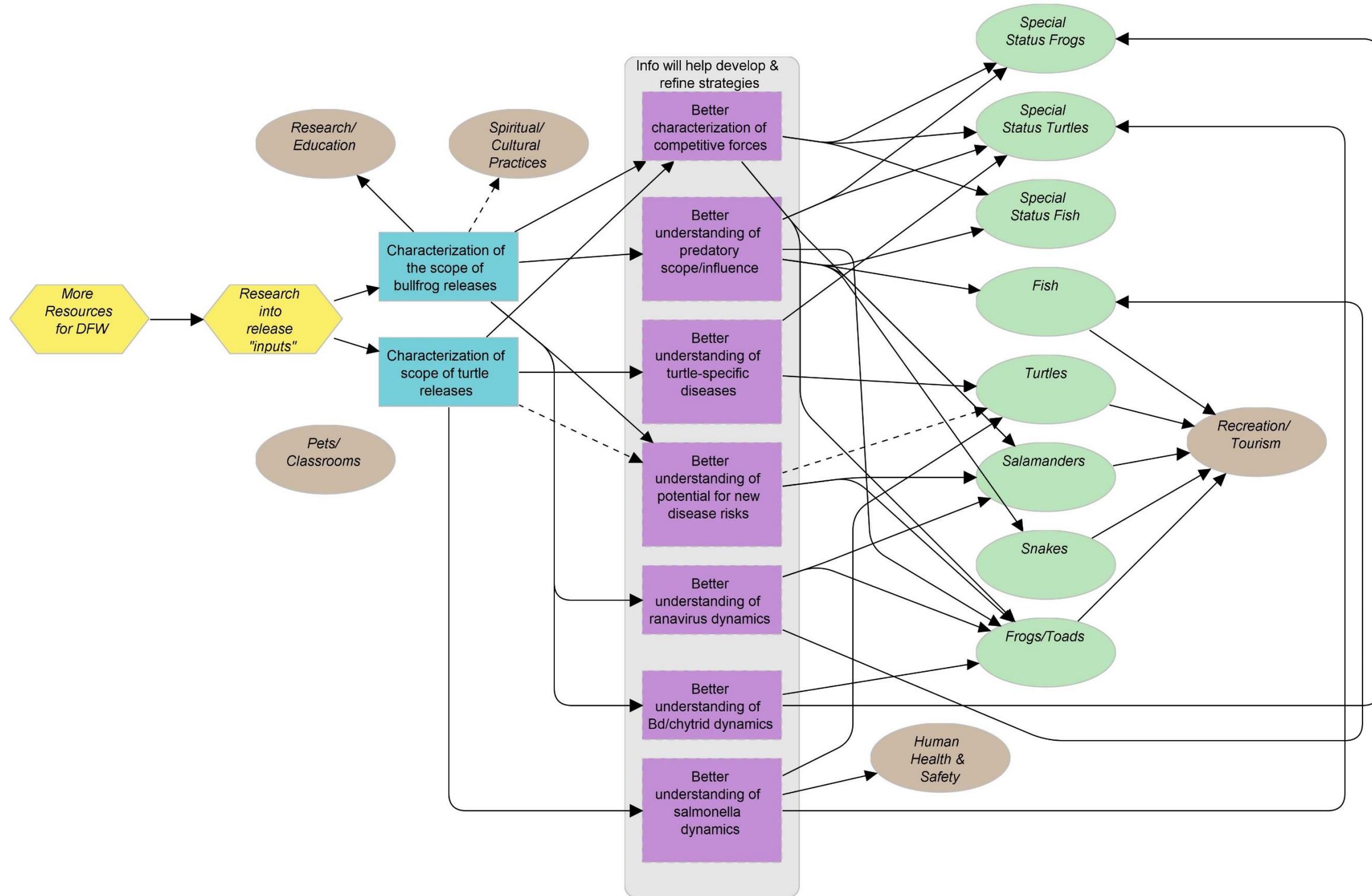
Results Chain: Education campaign



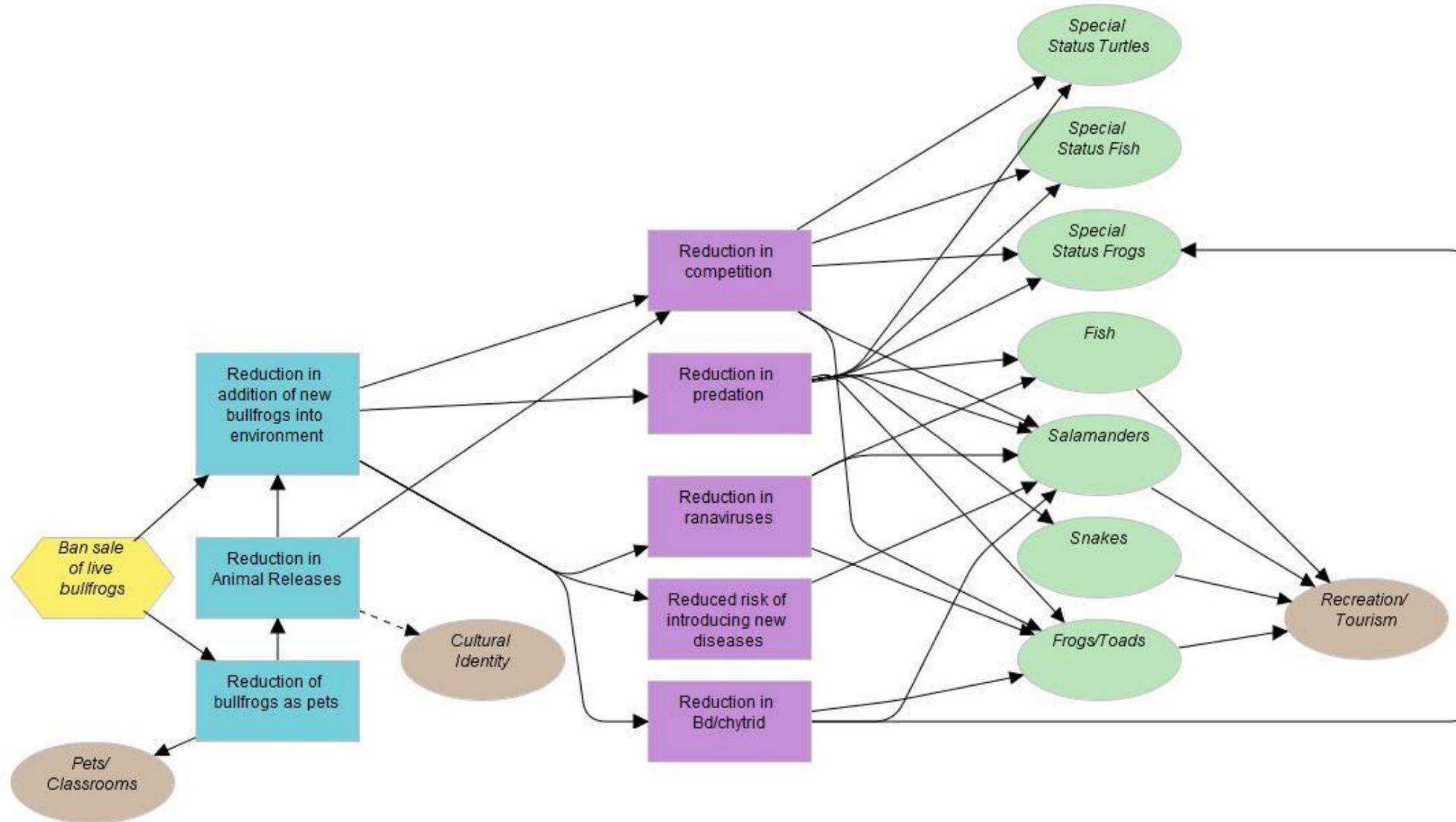
Results Chain: Habitat improvement



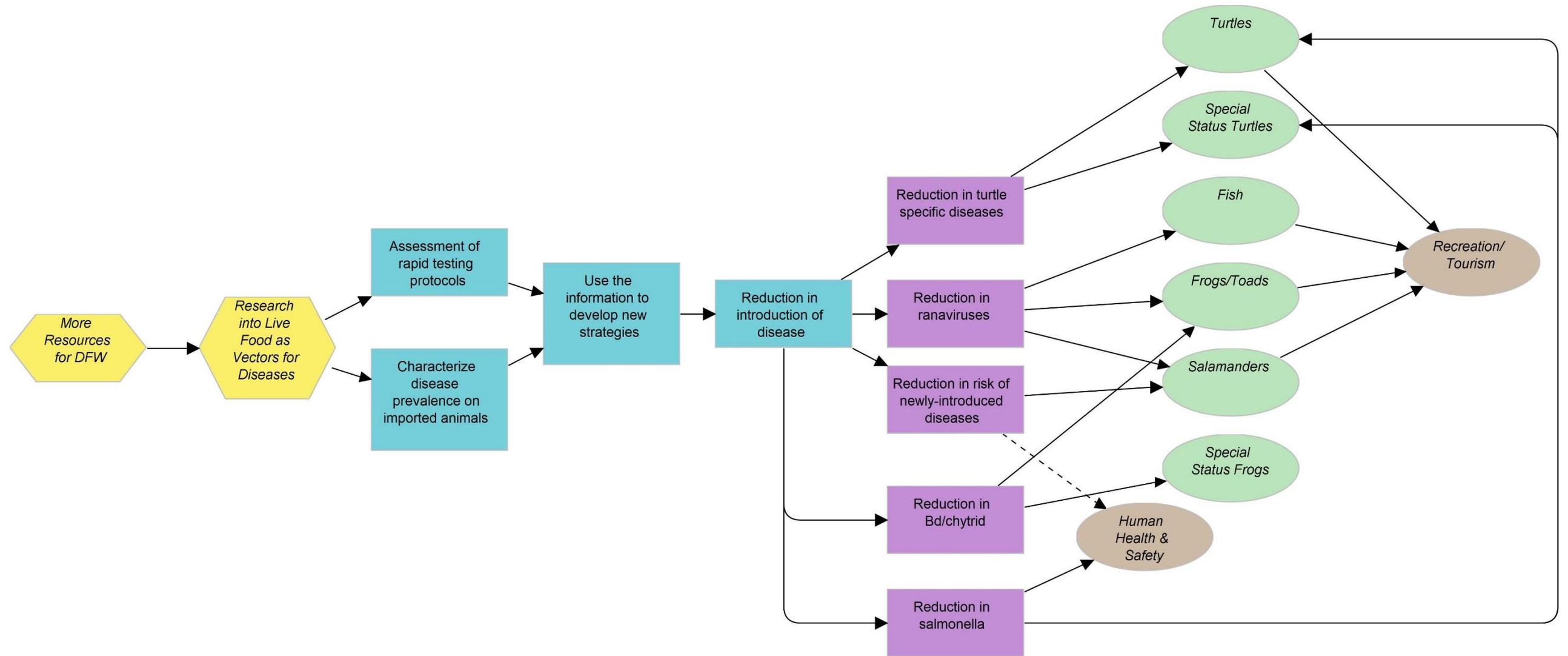
Results Chain: Research into release "inputs"



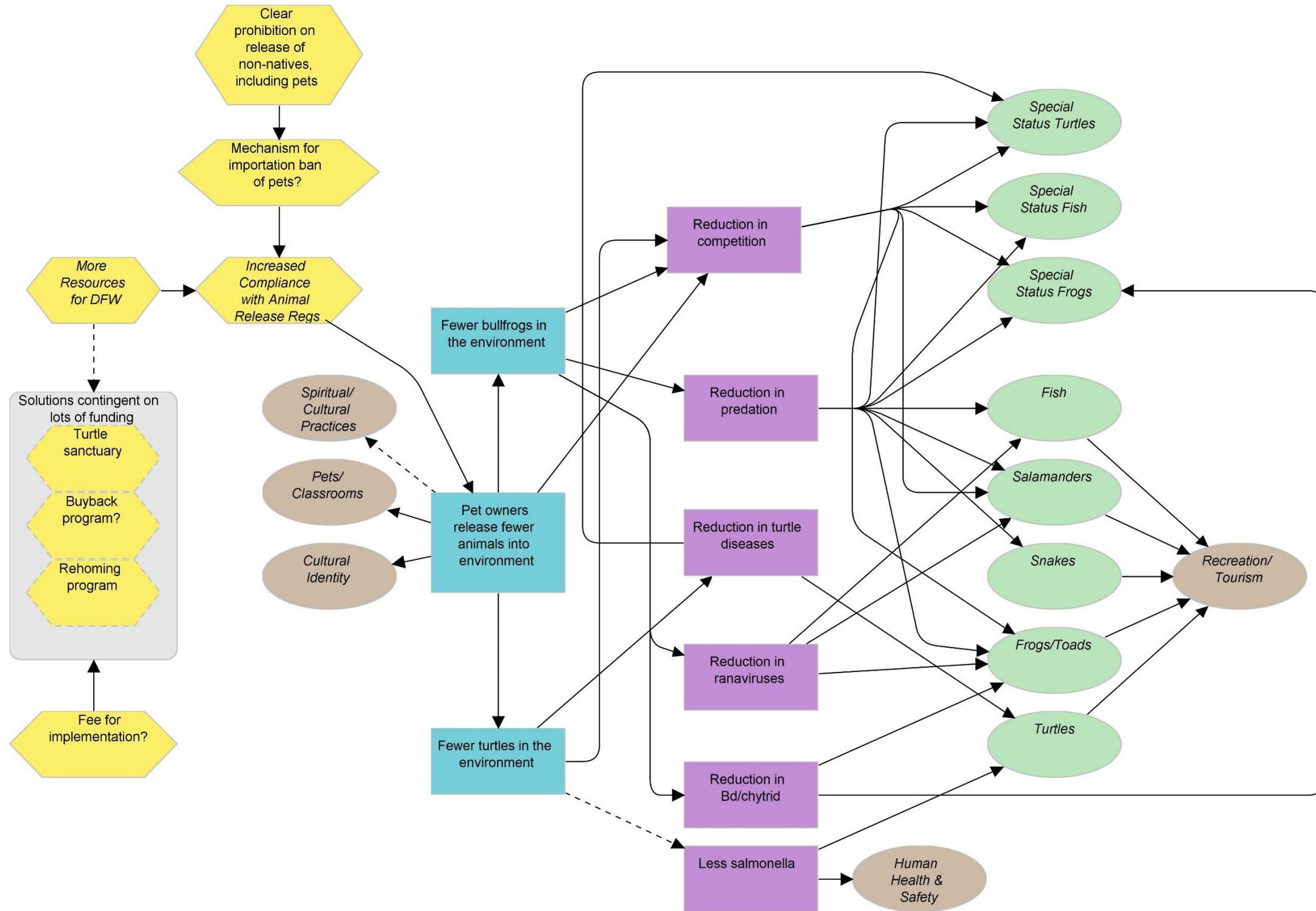
Results Chain: Ban sale of live bullfrogs



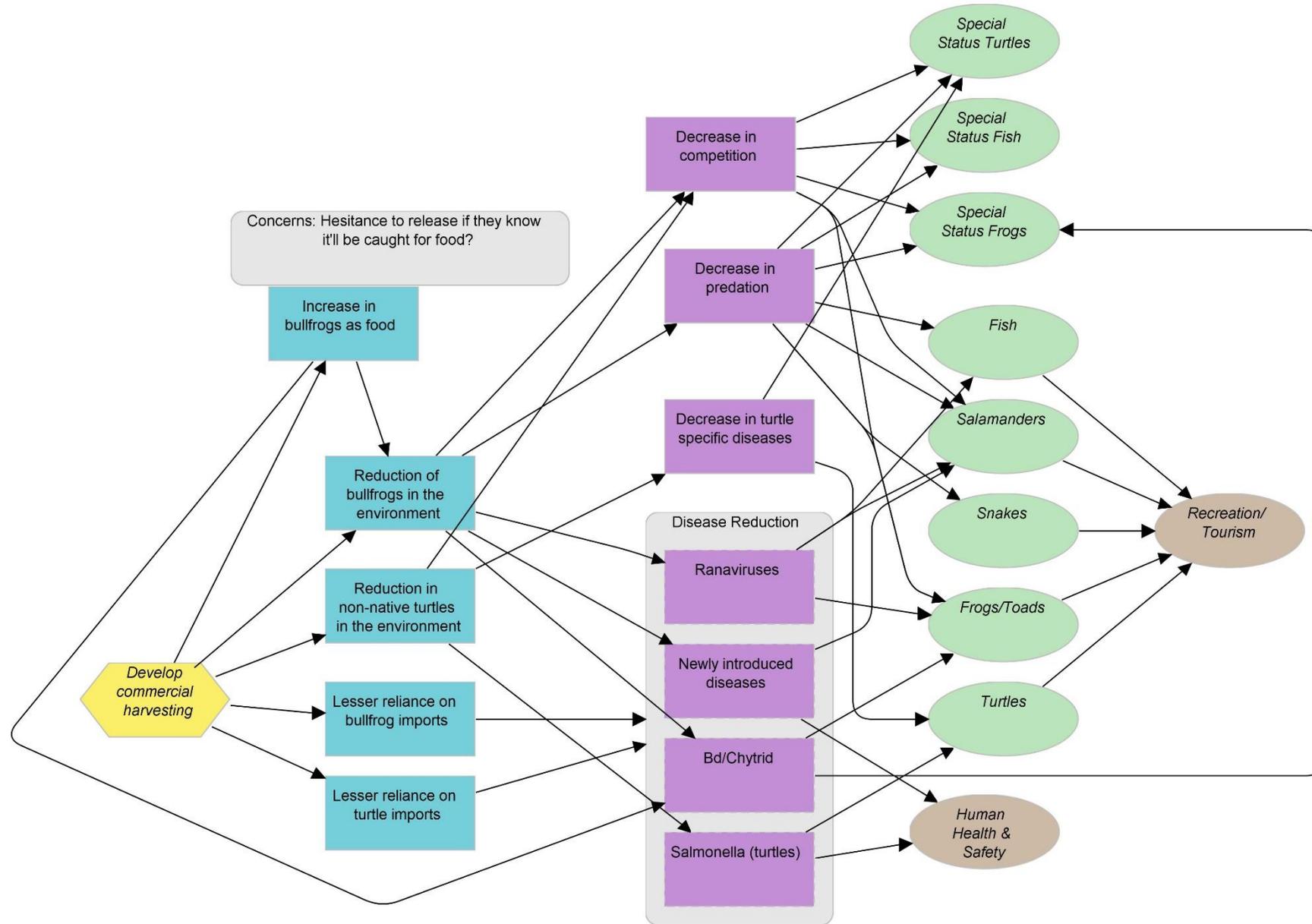
Results Chain: Research into live food as vectors for diseases



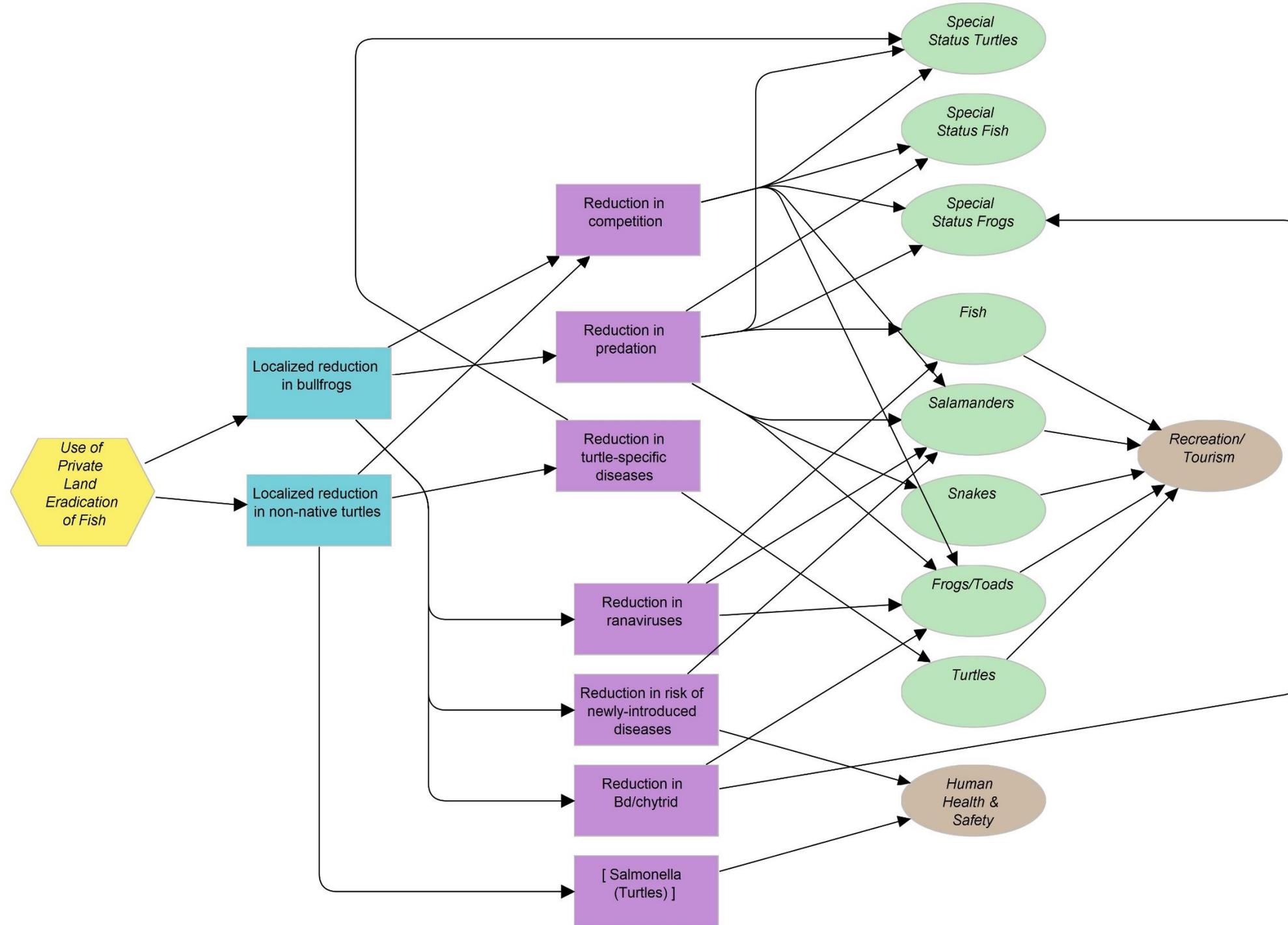
Results Chain: Increased compliance with animal release regulations



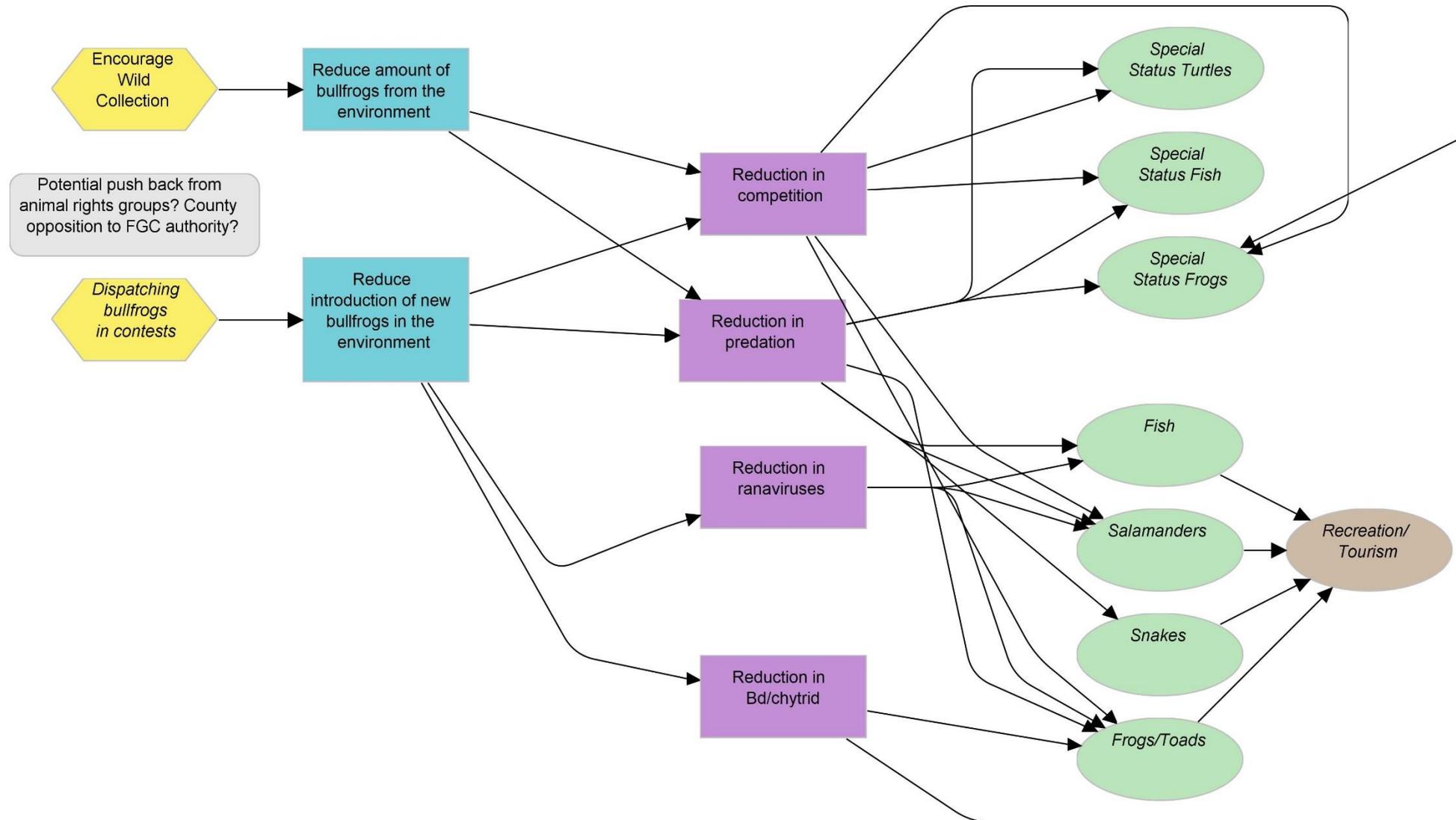
Results Chain: Develop commercial harvesting



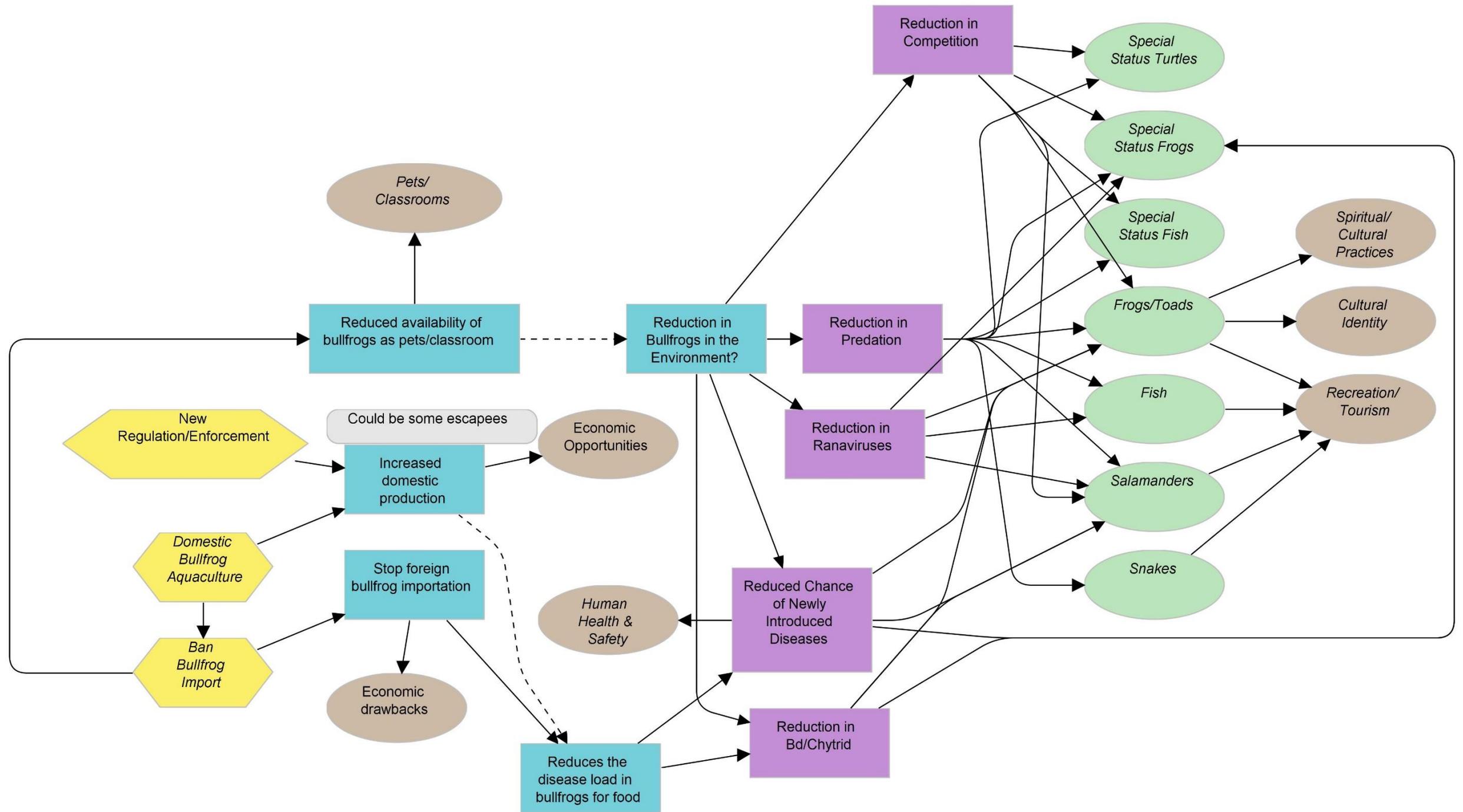
Results Chain: Use of private land eradication of fish



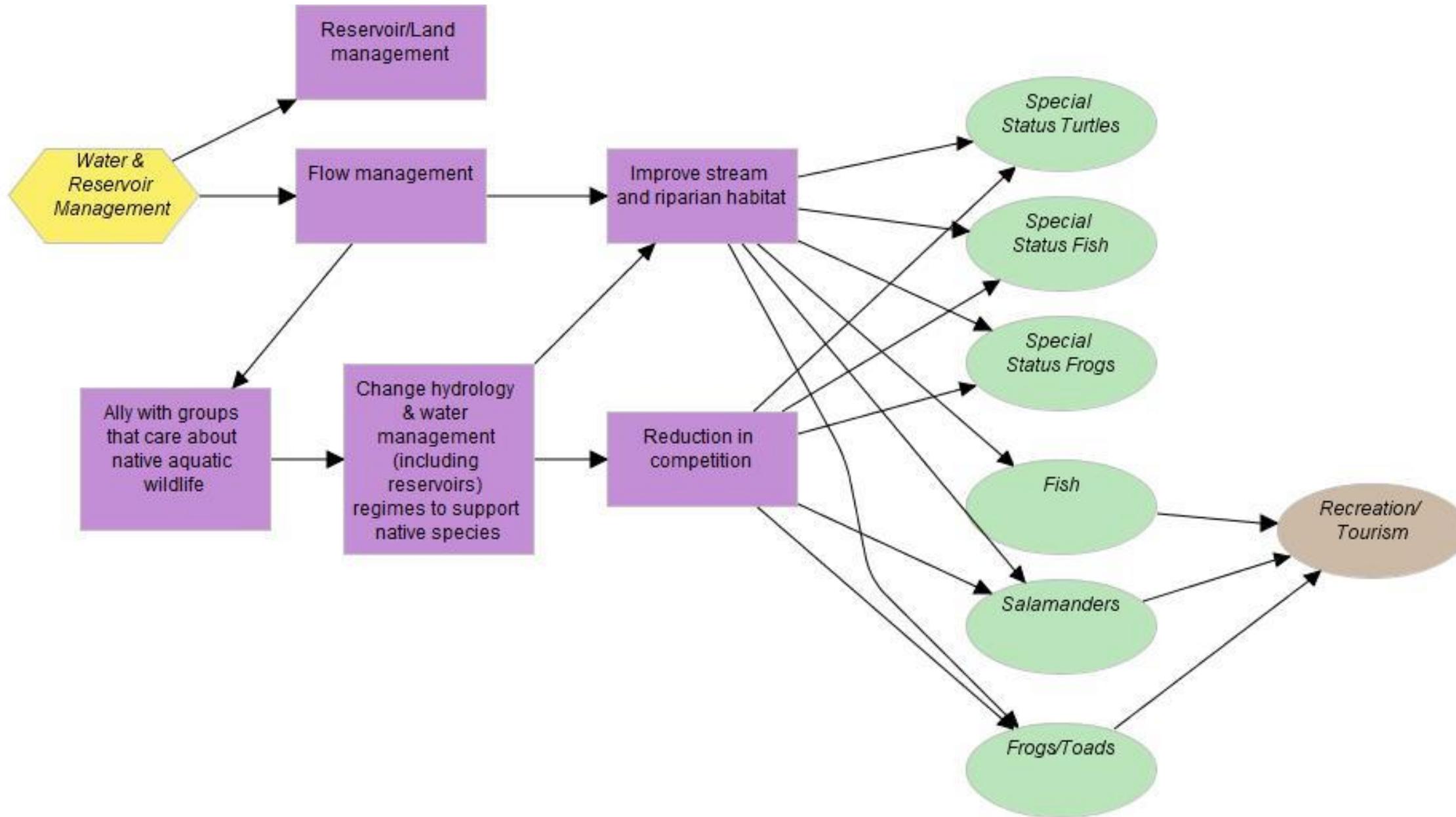
Results Chain: Jumping contest reforms



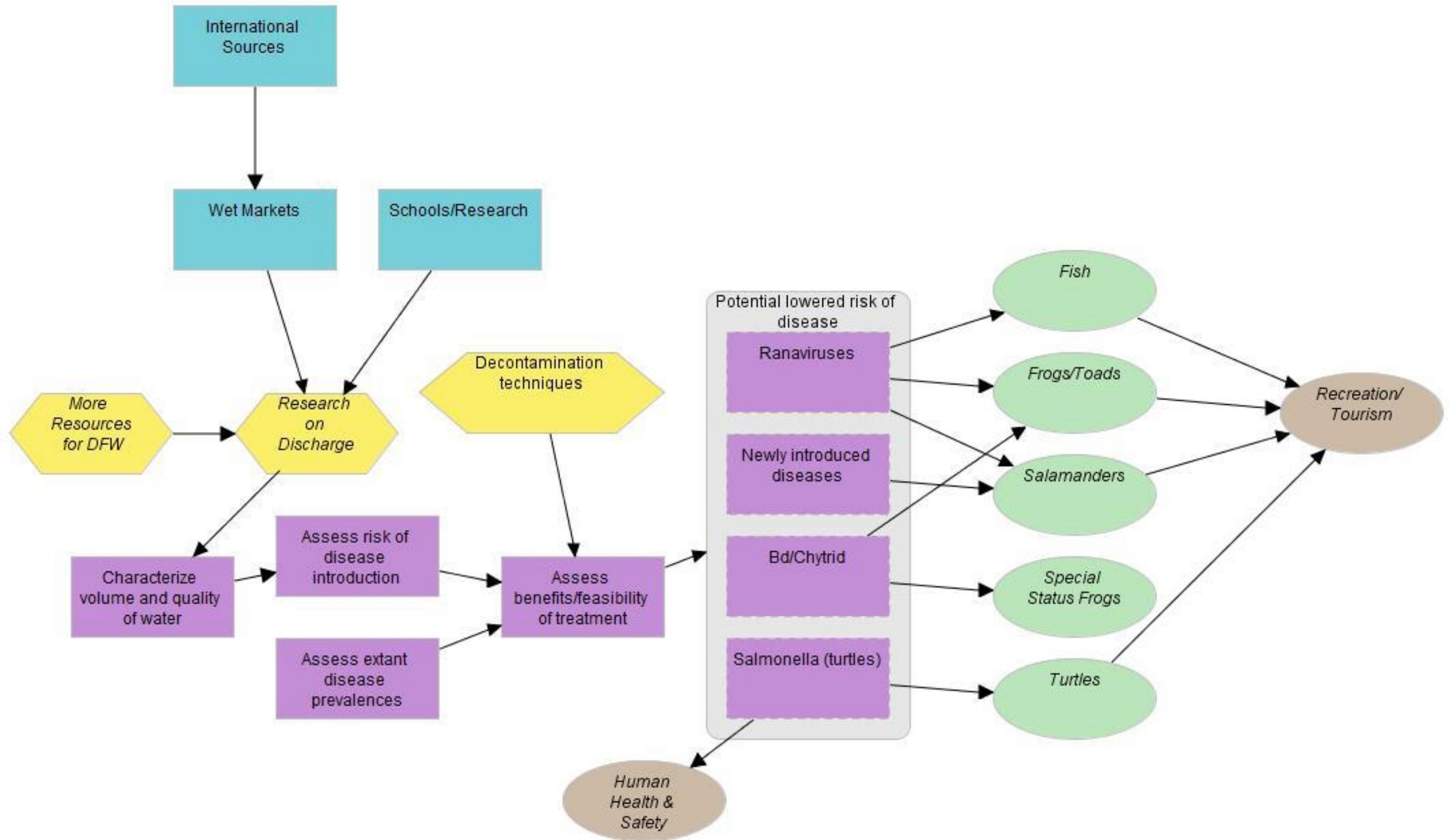
Results Chain: Ban bullfrog import



Results Chain: Water and reservoir management



Results Chain: Research on wastewater discharge



Agencies Notes

Item	Details
<ul style="list-style-type: none"> ● Ban bullfrog import 	<ul style="list-style-type: none"> ● Ban from anywhere outside California ● Novel pathogens may not be detectable, even from other states ● Other states may receive international imports
<ul style="list-style-type: none"> ● Domestic bullfrog aquaculture 	<ul style="list-style-type: none"> ● Probably unlikely to catch on unless an import ban is implemented ● Growers aren't pushing for import ban
<ul style="list-style-type: none"> ● Ban sale of live bullfrogs 	<ul style="list-style-type: none"> ● Possession would still be allowed ● Potentially ban of tadpoles and other avenues, not just live market ● Goal: Reduce the introduction of new bullfrogs in the environment ● Dead individuals/parts would be allowed ● Potential conflict with commercial harvest? ● Would likely need a specific carve out for frog jumping contests ● Potential switching to other species in the live markets ● Potential impacts to markets?
<ul style="list-style-type: none"> ● Bullfrogs as bait 	<ul style="list-style-type: none"> ● Encourage wild catch of bullfrogs and use them as bait ● Don't encourage a market of importation for bait ● Potentially ban sale of bullfrogs for bait but allow personal use
<ul style="list-style-type: none"> ● Develop commercial harvesting 	<ul style="list-style-type: none"> ● Economics & business model have to work out as a prerequisite ● Access to property also necessary ● Nexus with aquaculture? Creation of a permitting structure? Size limits to ensure accurate identification? Geographic or take limitations? ● See Title 14 226.7 -- bullfrogs would need to be added. T14 651, 658, 41.7; Also see Fish & Game Code 6850-6855CDFA regs -- ok to give pets to commercial harvesters for food? Possible way to reduce releases ● Permitting of harvesters? ● Very contextual – Highly dependent on overall strategies deployed
<ul style="list-style-type: none"> ● Education campaign 	<ul style="list-style-type: none"> ● Audience: live markets, pet owners, educational facilities, religious purposes, aquaculture facilities ● Don't release animals into the environment ● Collection event -- "Free 2 hour boat rental to whoever collects the most" ● Educate people about the availability of bullfrog harvest? R3?
<ul style="list-style-type: none"> ● Habitat improvement 	<ul style="list-style-type: none"> ● Creating base habitat conditions that favor native species and disfavor bullfrogs ● Water temperature (ex. colder water), running water, reestablish food webs, elimination of barriers

Item	Details
<ul style="list-style-type: none"> Increased compliance with animal release regs 	<ul style="list-style-type: none"> Illegal importation Should leave the market dead Release of wildlife Important role for local ordinances Probably mostly an education/outreach initiative, less an enforcement issue Signage, employee training at pet store
<ul style="list-style-type: none"> Mechanism for importation ban of pets? 	<ul style="list-style-type: none"> Require pet industry to PIT tag?
<ul style="list-style-type: none"> Turtle sanctuary 	<ul style="list-style-type: none"> For pet owners that don't want their pets anymore
<ul style="list-style-type: none"> Dispatching bullfrogs in contests 	<ul style="list-style-type: none"> Kill any bullfrogs that contestants don't want to keep (driven by animal rights groups) See F&GC Sec 6855 -- permit needed?
<ul style="list-style-type: none"> Encourage wild collection 	<ul style="list-style-type: none"> Turn the bullfrog competition into an amphibian conservation event
<ul style="list-style-type: none"> Commission authority to regulate contests 	<ul style="list-style-type: none"> Fish and Game Code addition
<ul style="list-style-type: none"> Jumping contests 	<ul style="list-style-type: none"> Dispatching of frogs Encouraging wild collection Working with permit holders? Outreach to event holders?
<ul style="list-style-type: none"> Research into release "inputs" 	<ul style="list-style-type: none"> What is the release rate of animals from live markets? How many pets are released into the wild? Are new influxes of diseased individuals additive to those already in the population?
<ul style="list-style-type: none"> Decontamination techniques 	<ul style="list-style-type: none"> Treatment with bleach/antifungal agent
<ul style="list-style-type: none"> Research on discharge 	<ul style="list-style-type: none"> Discharge: Any water that comes into contact with animals

Item	Details
 Use of private land eradication of fish	<ul style="list-style-type: none"> • Turtles are not fish -- would need to be updated to include them • Take methods might need to be reexamined: Add gigging • Form: Fish & Game 5501 (T14 226.5, 226.7), form Fish & Game 793 • Also see Fish & Game Code 6850-6855; use 6855 as a general authority • Doesn't necessarily have to be limited to private lands
 Frog jumping contests	<ul style="list-style-type: none"> • Sourcing bullfrogs from biological supply houses?
 Bullfrogs as pets	<ul style="list-style-type: none"> • Probably a negligible issue
 Online sales	<ul style="list-style-type: none"> • Education loophole?
 Importation of non-native frogs	<ul style="list-style-type: none"> • <i>Xenopus sp.</i> (African clawed frog), cane toads
 Turtles in the environment	<ul style="list-style-type: none"> • Red-eared sliders, painted turtles, map turtles, snapping turtles (common and alligator), softshell turtles
 Turtle specific diseases	<ul style="list-style-type: none"> • Western pond turtle, among others • Turtle shell diseases • Upper respiratory diseases
 Bullfrogs in the environment to habitat fragmentation	<ul style="list-style-type: none"> • Aquatic footprint contracts increases contact between bullfrogs & native spp.
 Animal releases to competition	<ul style="list-style-type: none"> • Religious releases are uncertain
 Competition to frogs/toads	<ul style="list-style-type: none"> • Foothill yellow-legged frog, mountain yellow-legged frog, etc.
 Animal releases to cultural identity	<ul style="list-style-type: none"> • Religious animal releases
 Reduced availability of bullfrogs as pets/classroom	<ul style="list-style-type: none"> • This is minor

Item	Details
<input type="checkbox"/> Stops new introductions	<ul style="list-style-type: none"> Minimizes relocation of bullfrogs, preventing redistribution
<input type="radio"/> Recreation/ Tourism	<ul style="list-style-type: none"> Banning contests could have negative economic effects
<input type="checkbox"/> Reduction of bullfrogs as pets	<ul style="list-style-type: none"> Reduction of bullfrogs as pets -- self-collection from the wild is the only pathway (same as OR) Scientific collecting permit would be needed for classroom use: Title 14 Section 658. Commercial Take of Bullfrogs for sale to scientific or education institutions New permit for classrooms would likely take Code modification
<input type="checkbox"/> Reduction in Animal Releases	<ul style="list-style-type: none"> Live market escapees Classroom releases
<input type="checkbox"/> Reduced risk of introducing new diseases	<ul style="list-style-type: none"> High impact to this threat
<input type="checkbox"/> More people start using bullfrogs as bait	<ul style="list-style-type: none"> Effectiveness is dependent on the level of implementation/adoption Potential side benefit of awareness
<input type="checkbox"/> Reduction in releases	<ul style="list-style-type: none"> from live markets, pet owners, educational facilities, religious purposes, aquaculture facilities
<input type="checkbox"/> Assessment of rapid testing protocols	<ul style="list-style-type: none"> APHIS?
<input type="checkbox"/> Reservoir/Land management	<ul style="list-style-type: none"> Muni code prohibiting sale No bait, cooler inspections, signage
<input type="checkbox"/> Flow management	<ul style="list-style-type: none"> Interrupt the larval phase More natural hydrography downstream, create sedimentation and hydrology/hydrography conducive to native species Large scouring flow can recreate gravel bars, remove riparian vegetation, push bullfrog tadpoles away, increase complexity and decrease channelization, flow dehomogenization

Threat Rating Details

Participants rated each threat-target pair as high, medium, or low in scope, severity, and irreversibility.

Scope - Most commonly defined spatially as the proportion of the target that can reasonably be expected to be affected by the threat within ten years given the continuation of current circumstances and trends. For ecosystems and ecological communities, measured as the proportion of the target's occurrence. For species, measured as the proportion of the target's population.

- **Very High:** The threat is likely to be pervasive in its scope, affecting the target across all or most (71-100%) of its occurrence/population.
- **High:** The threat is likely to be widespread in its scope, affecting the target across much (31-70%) of its occurrence/population.
- **Medium:** The threat is likely to be restricted in its scope, affecting the target across some (11-30%) of its occurrence/population.
- **Low:** The threat is likely to be very narrow in its scope, affecting the target across a small proportion (1-10%) of its occurrence/population.

Severity - Within the scope, the level of damage to the target from the threat that can reasonably be expected given the continuation of current circumstances and trends. For ecosystems and ecological communities, typically measured as the degree of destruction or degradation of the target within the scope. For species, usually measured as the degree of reduction of the target population within the scope.

- **Very High:** Within the scope, the threat is likely to destroy or eliminate the target, or reduce its population by 71-100% within ten years or three generations.
- **High:** Within the scope, the threat is likely to seriously degrade/reduce the target or reduce its population by 31-70% within ten years or three generations.
- **Medium:** Within the scope, the threat is likely to moderately degrade/reduce the target or reduce its population by 11-30% within ten years or three generations.
- **Low:** Within the scope, the threat is likely to only slightly degrade/reduce the target or reduce its population by 1-10% within ten years or three generations.

Irreversibility (Permanence) - The degree to which the effects of a threat can be reversed and the target affected by the threat restored.

- **Very High:** The effects of the threat cannot be reversed and it is very unlikely the target can be restored, and/or it would take more than 100 years to achieve this (e.g., wetlands converted to a shopping center).
- **High:** The effects of the threat can technically be reversed and the target restored, but it is not practically affordable and/or it would take 21-100 years to achieve this (e.g., wetland converted to agriculture).
- **Medium:** The effects of the threat can be reversed and the target restored with a reasonable commitment of resources and/or within 6-20 years (e.g., ditching and draining of wetland).
- **Low:** The effects of the threat are easily reversible and the target can be easily restored at a relatively low cost and/or within 0-5 years (e.g., off-road vehicles trespassing in wetland).

Permanence applies to the *effects of the threat* on the target, not the threat itself. In other words, it is not a measure of how difficult it is to stop the threat, but rather to undo the stress caused by the threat on the target. It is important to note that the use of the permanence rating as specified is largely in respect to prioritizing potential threats. If a threat is looming that will cause irreversible damage, then it makes sense to try to address that threat. However, if the threat has already occurred and the irreversible damage has already taken place, then it may not make sense to prioritize that threat for action.

Threat Ratings

	Threats \ Targets	Special Status Frogs	Turtles	Fish	Salamanders	Biodiversity	Snakes	Frogs/Toads	Special Status Turtles	Special Status Fish	Summary Threat Rating
■	Bd/Chytrid	High			Low	Not Specified		High			High
■	Competition	High			Medium	Not Specified		High	Very High	Medium	High
■	Direct Predation on Species	High		Low	Medium	Not Specified	Low	Medium	Low	Low	Medium
■	Habitat Fragmentation	High		Low	Low	Not Specified		Low	High	Medium	High
■	Habitat Quality Issues	High			N/A	Not Specified		Low	High	Very High	High
■	Increased demand for water	Very High		High	Low	Not Specified		High	Very High	Very High	Very High
■	Newly Introduced Diseases (B. Sal)				Medium	Not Specified					Low
■	Ranaviruses			Medium	Not Specified	Not Specified		Very High			High
■	Salmonella (Turtles)										Not Specified
■	Turtle Specific Diseases		Medium			Not Specified			Medium		Medium

	Threats \ Targets	Special Status Frogs	Turtles	Fish	Salamanders	Biodiversity	Snakes	Frogs/Toads	Special Status Turtles	Special Status Fish	Summary Threat Rating
■	Wastewater	Not Specified		Not Specified	Low	Not Specified		Low			Low
Summary Target Ratings:		Very High	Low	Medium	Medium	Not Specified	Low	Very High	Very High	Very High	Very High

Special Status Frogs

Threat	Scope	Severity	Irreversibility	Summary Threat Rating	Comments
Habitat Fragmentation	High	High	High	High	
Direct Predation on Species	High	Very High	High	High	
Habitat Quality Issues	High	High	High	High	
Competition	High	Very High	High	High	<ul style="list-style-type: none"> • Good habitat may help alleviate the severity
Bd/Chytrid	Very High	High	High	High	
Wastewater	Not Specified	Not Specified	Not Specified	Not Specified	
Increased demand for water	Very High	Very High	Very High	Very High	<ul style="list-style-type: none"> • Low flows & slower waters allow bullfrogs to flourish

Turtles

Threat	Scope	Severity	Irreversibility	Summary Threat Rating	Comments
Turtle Specific Diseases	Low	High	Very High	Medium	

Fish

Threat	Scope	Severity	Irreversibility	Summary Threat Rating	Comments
Habitat Fragmentation	Low	Medium	High	Low	<ul style="list-style-type: none"> • Could be some negative aspects to habitat connection, such as bullfrog expansion
Direct Predation on Species	Medium	Low	High	Low	<ul style="list-style-type: none"> • Questions about density, life stages, particular spp that bullfrogs are eating • Sticklebacks
Wastewater	Not Specified	Not Specified	Not Specified	Not Specified	
Increased demand for water	High	High	High	High	
Ranaviruses	Low	Medium	Very High	Medium	<ul style="list-style-type: none"> • Particularly bullfrogs as a vector

Salamanders

Threat	Scope	Severity	Irreversibility	Summary Threat Rating	Comments
Habitat Fragmentation	Low	Low	High	Low	
Direct Predation on Species	Medium	Medium	High	Medium	<ul style="list-style-type: none"> • Mostly predation on larvae
Habitat Quality Issues	Not Specified	Not Specified	Not Specified	Not Specified	
Competition	Medium	Medium	High	Medium	<ul style="list-style-type: none"> • Primarily aquatic • Baseline is already degraded severely, so incremental damages may be underestimated
Bd/Chytrid	Low	Medium	High	Low	
Newly Introduced Diseases (B. Sal)	Low	Low	Very High	Medium	<ul style="list-style-type: none"> • No documented cases in CA. US? High risk if introduced
Wastewater	Low	Low	Medium	Low	<ul style="list-style-type: none"> • Wastewater to environment - unknown, could be concentrated in some areas • Main concern is dumping untreated water down direct to water • Unknown effectiveness of water treatment on diseases
Increased demand for water	Low	Very High	High	Low	<ul style="list-style-type: none"> • Full years of incomplete breeding due to desiccation -- how much is due to water demand?
Ranaviruses	Low	Not Specified	Not Specified	Not Specified	

Snakes

Threat	Scope	Severity	Irreversibility	Summary Threat Rating	Comments
Direct Predation on Species	Low	Low	High	Low	

Frogs/Toads

Threat	Scope	Severity	Irreversibility	Summary Threat Rating	Comments
Habitat Fragmentation	Low	Medium	High	Low	

Threat	Scope	Severity	Irreversibility	Summary Threat Rating	Comments
Direct Predation on Species	High	Medium	High	Medium	
Habitat Quality Issues	Low	Medium	High	Low	
Competition	High	Very High	High	High	
Bd/Chytrid	High	High	High	High	<ul style="list-style-type: none"> • Scope: Some pockets that may not have seen chytrid • Severity: Depends on new introduction vs. old, some populations may not exist without intervention, treatable
Wastewater	Low	Low	Medium	Low	<ul style="list-style-type: none"> • Wastewater to environment - unknown, could be concentrated in some areas • Main concern is dumping untreated water down direct to water • Unknown effectiveness of water treatment on diseases
Increased demand for water	High	High	High	High	
Ranaviruses	High	High	Very High	Very High	<ul style="list-style-type: none"> • Unknown scope

Special Status Turtles

Threat	Scope	Severity	Irreversibility	Summary Threat Rating	Comments
Habitat Fragmentation	High	High	High	High	
Direct Predation on Species	Low	Low	Low	Low	<ul style="list-style-type: none"> • Bullfrogs only • Questions about snapping turtles eating special status turtles
Habitat Quality Issues	High	High	High	High	
Competition	Very High	Very High	Medium	Very High	<ul style="list-style-type: none"> • Turtle-turtle competition is key
Turtle Specific Diseases	Low	High	Very High	Medium	
Increased demand for water	Very High	Very High	High	Very High	

Special Status Fish

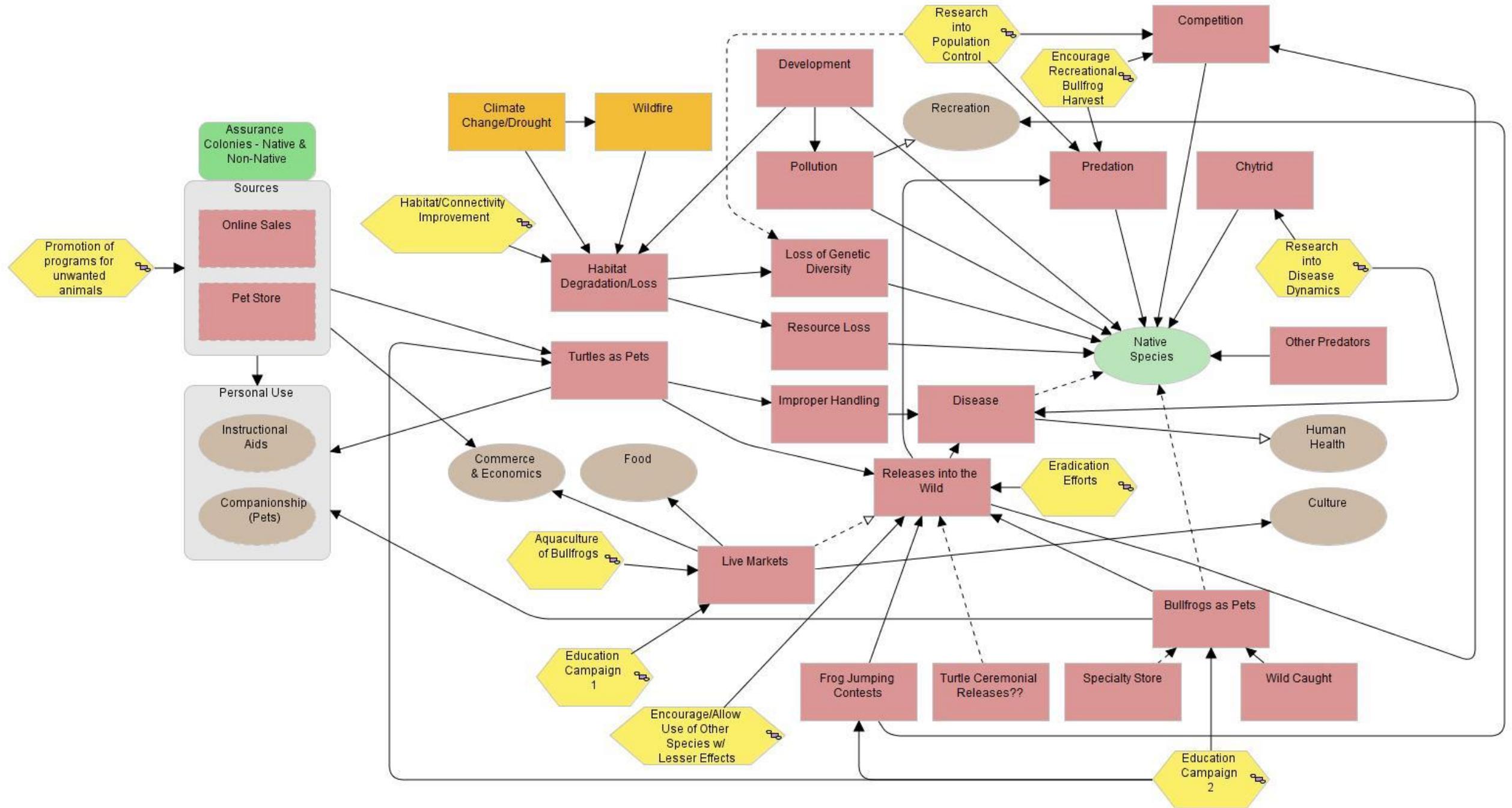
Threat	Scope	Severity	Irreversibility	Summary Threat Rating	Comments
Habitat Fragmentation	Medium	High	High	Medium	
Direct Predation on Species	Low	Medium	High	Low	
Habitat Quality Issues	Very High	Very High	High	Very High	
Competition	Medium	Medium	High	Medium	
Increased demand for water	Very High	Very High	Very High	Very High	

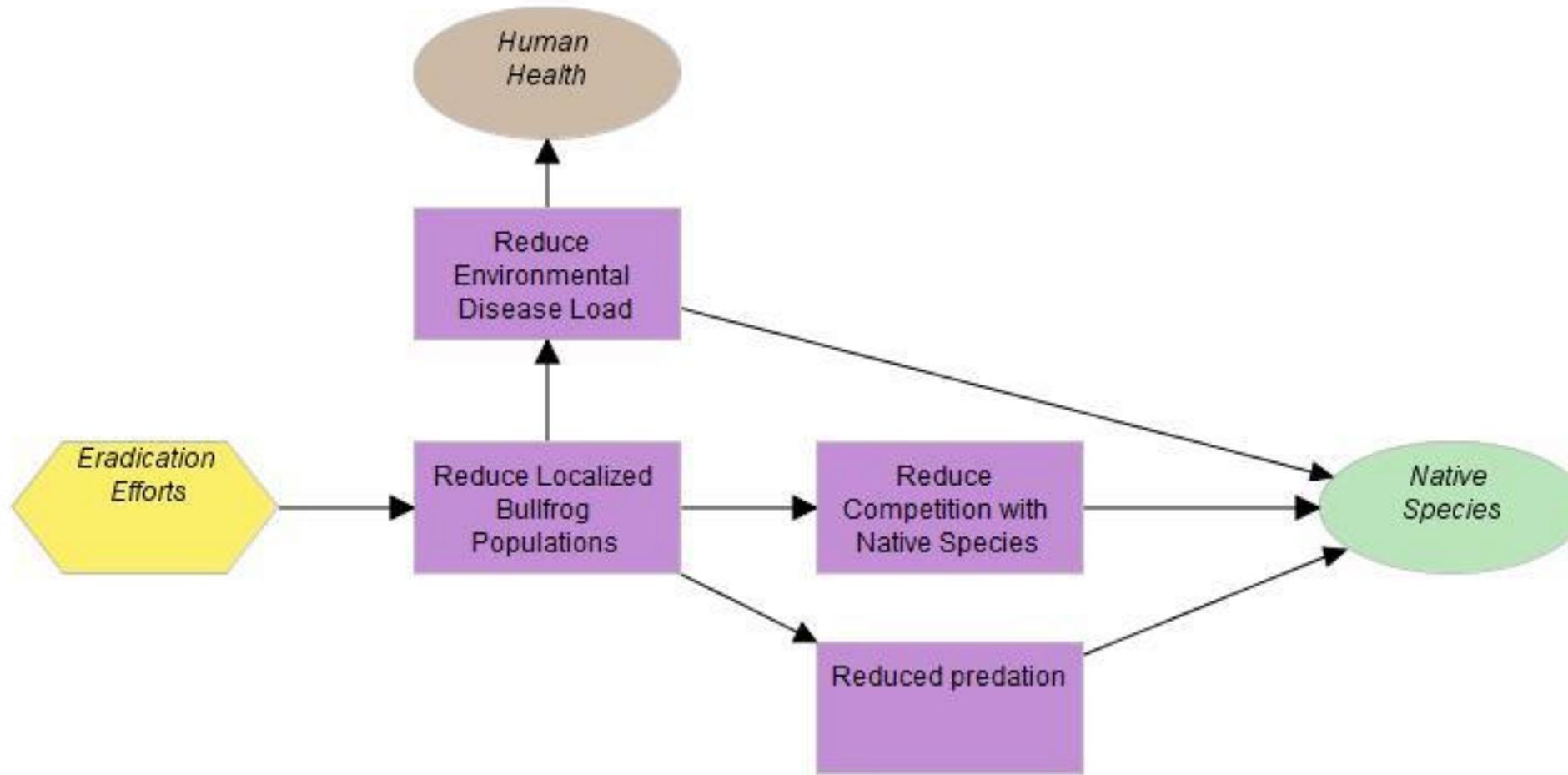
Industry Group Analysis

Scope and Vision

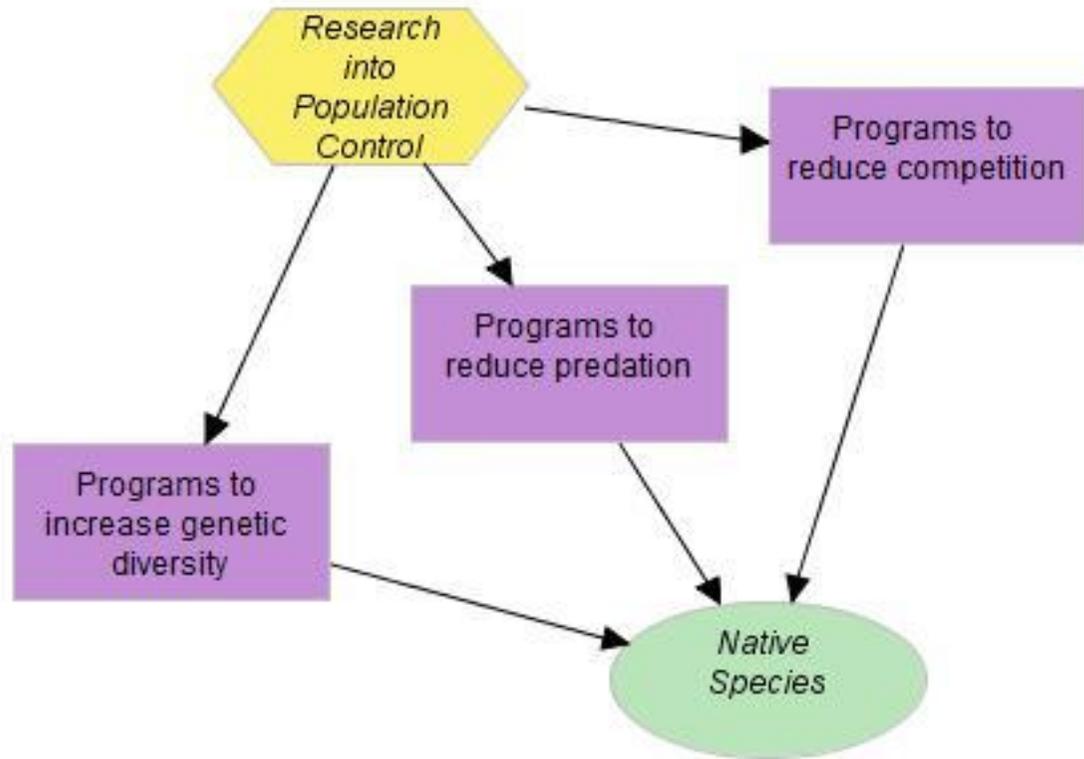
Scope/Site Name	California
Vision Statement Text	Our vision of California is one where conservation of native species coexists with access to culturally valuable animals for traditional foods, educational research, and companions, while promoting economic opportunity, recreation, consumer education, feasible management, and effective enforcement concerning harm to other species.
Comments	

Main Diagram

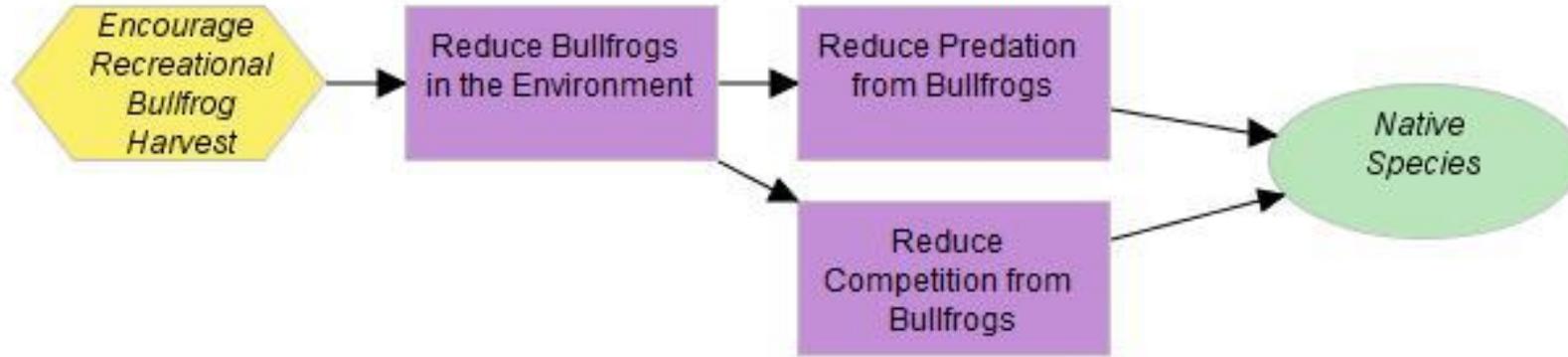


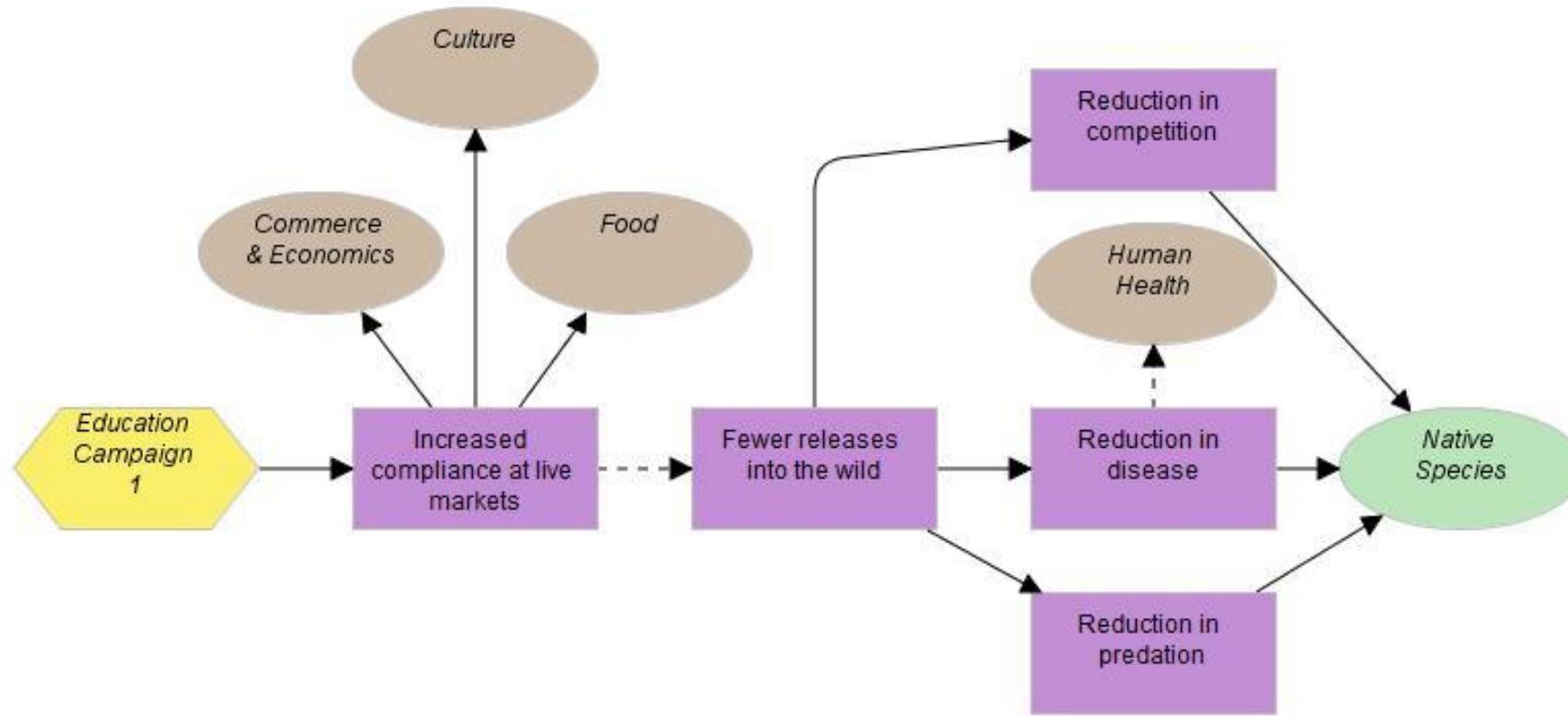


Results Chain: Research into population control techniques

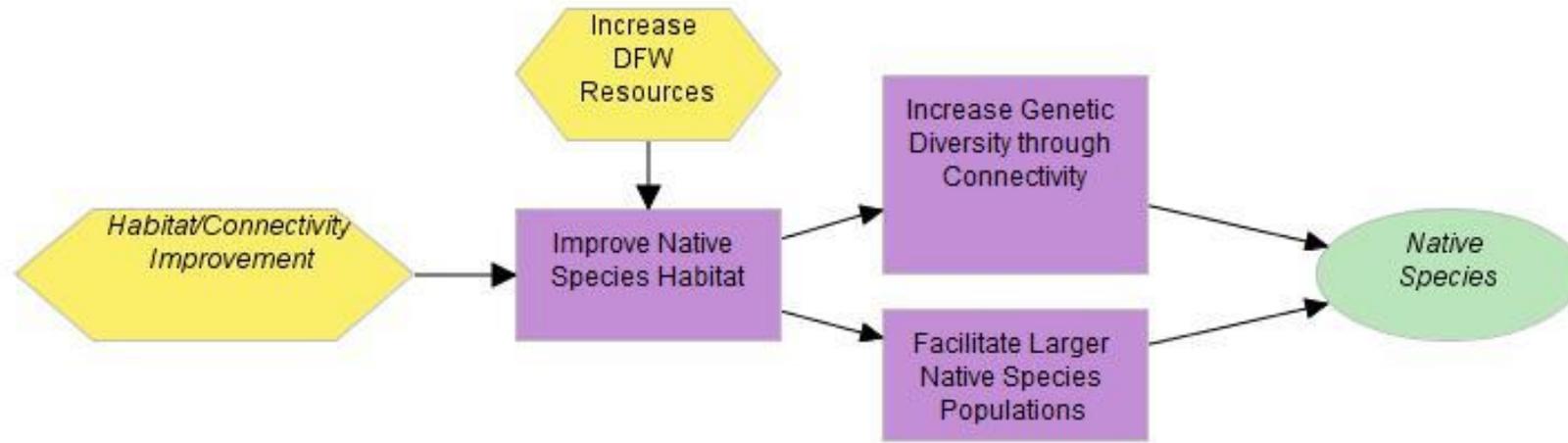


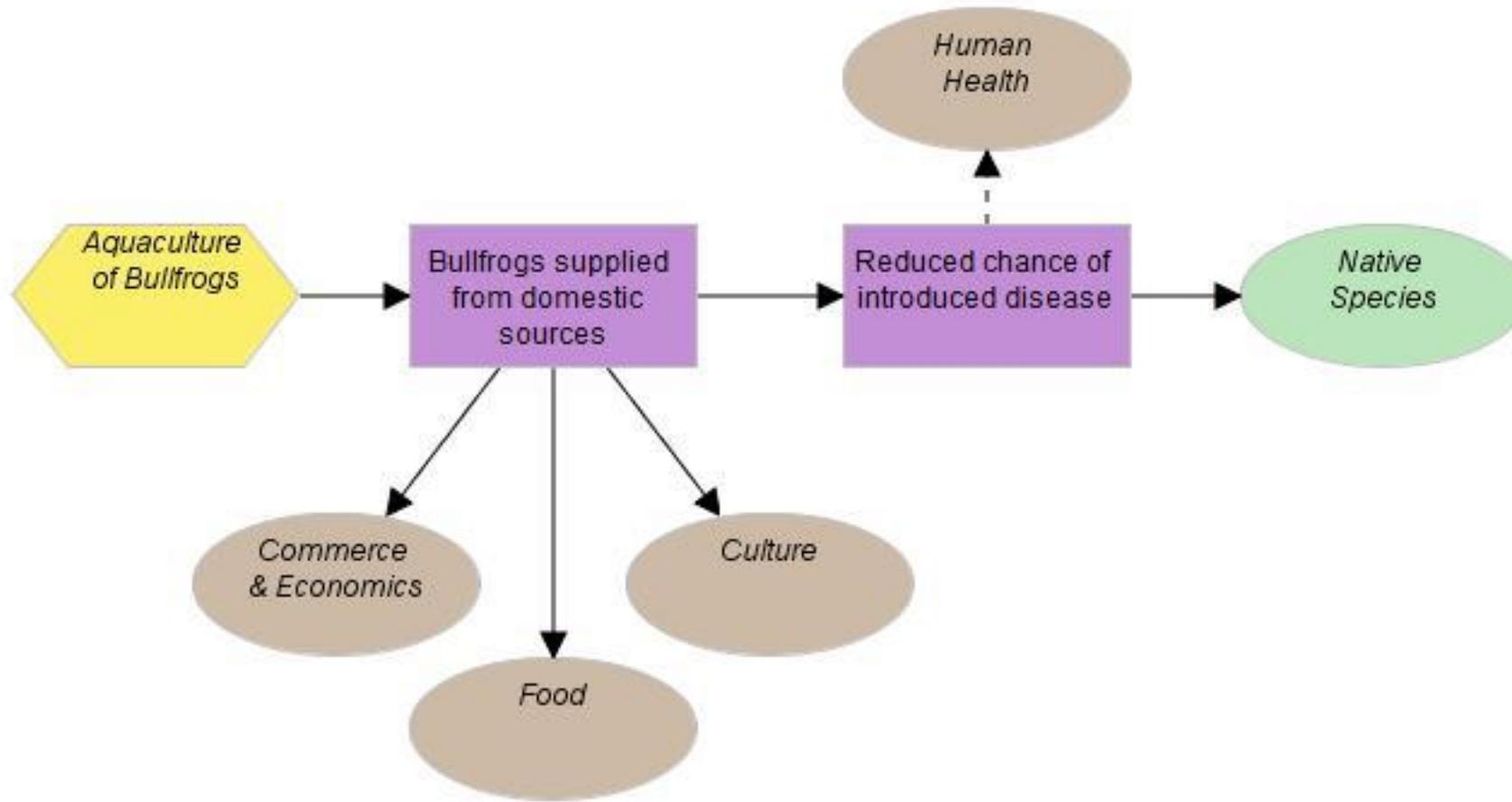
Results Chain: Encourage recreational bullfrog harvest



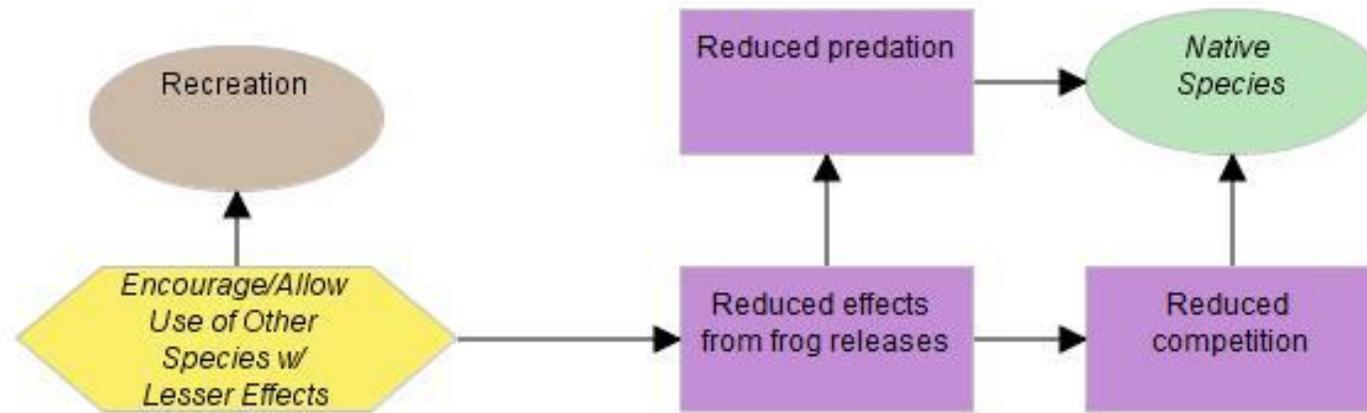


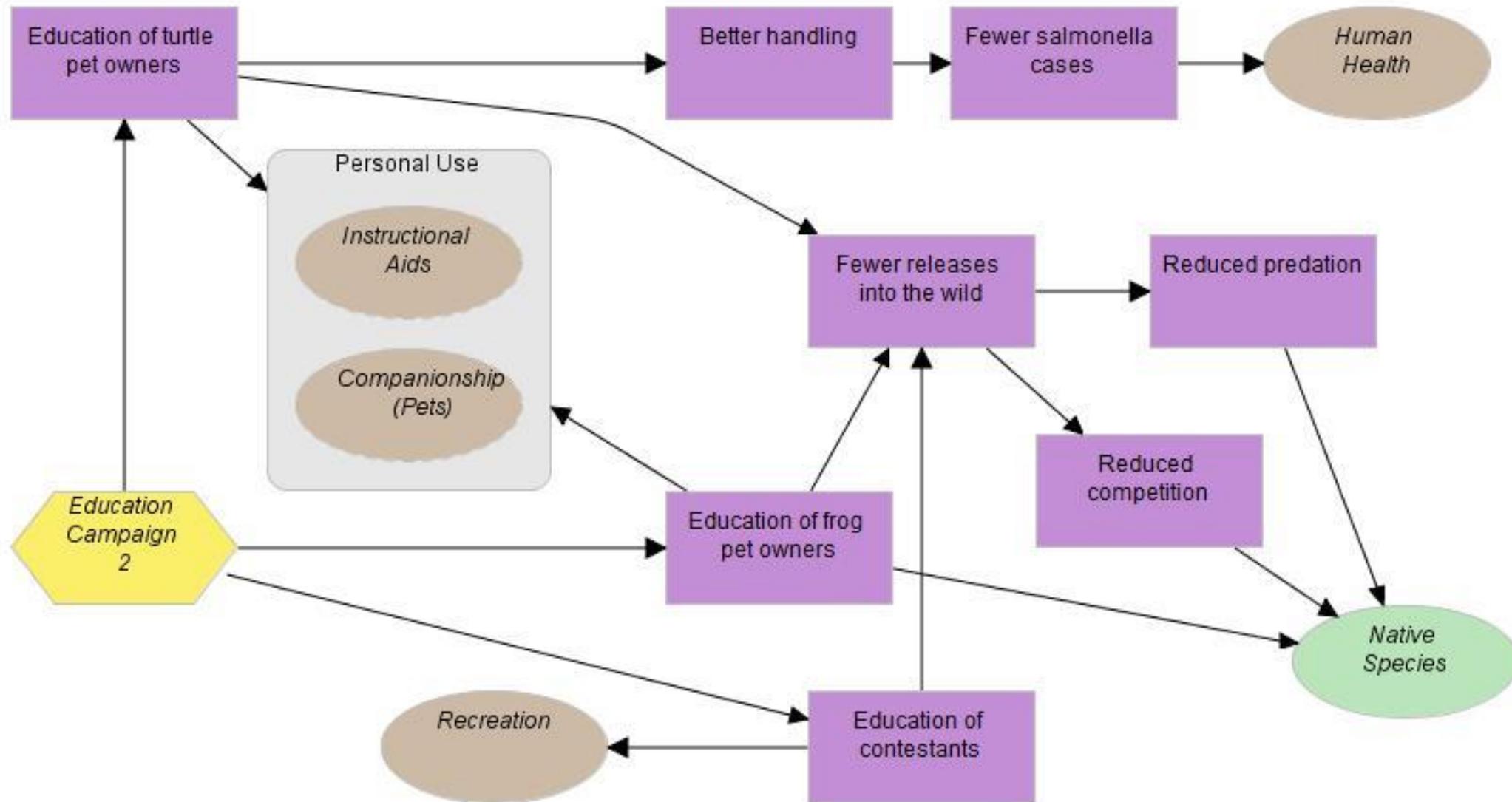
Results Chain: Habitat/connectivity improvement



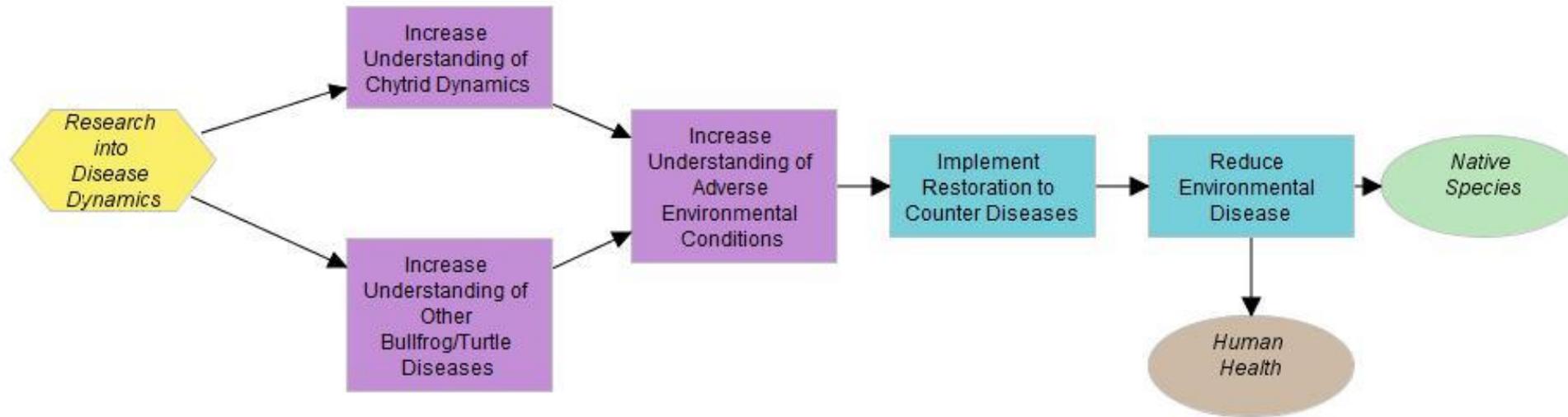


Results Chain: Encourage/allow use of other species w/ lesser effects

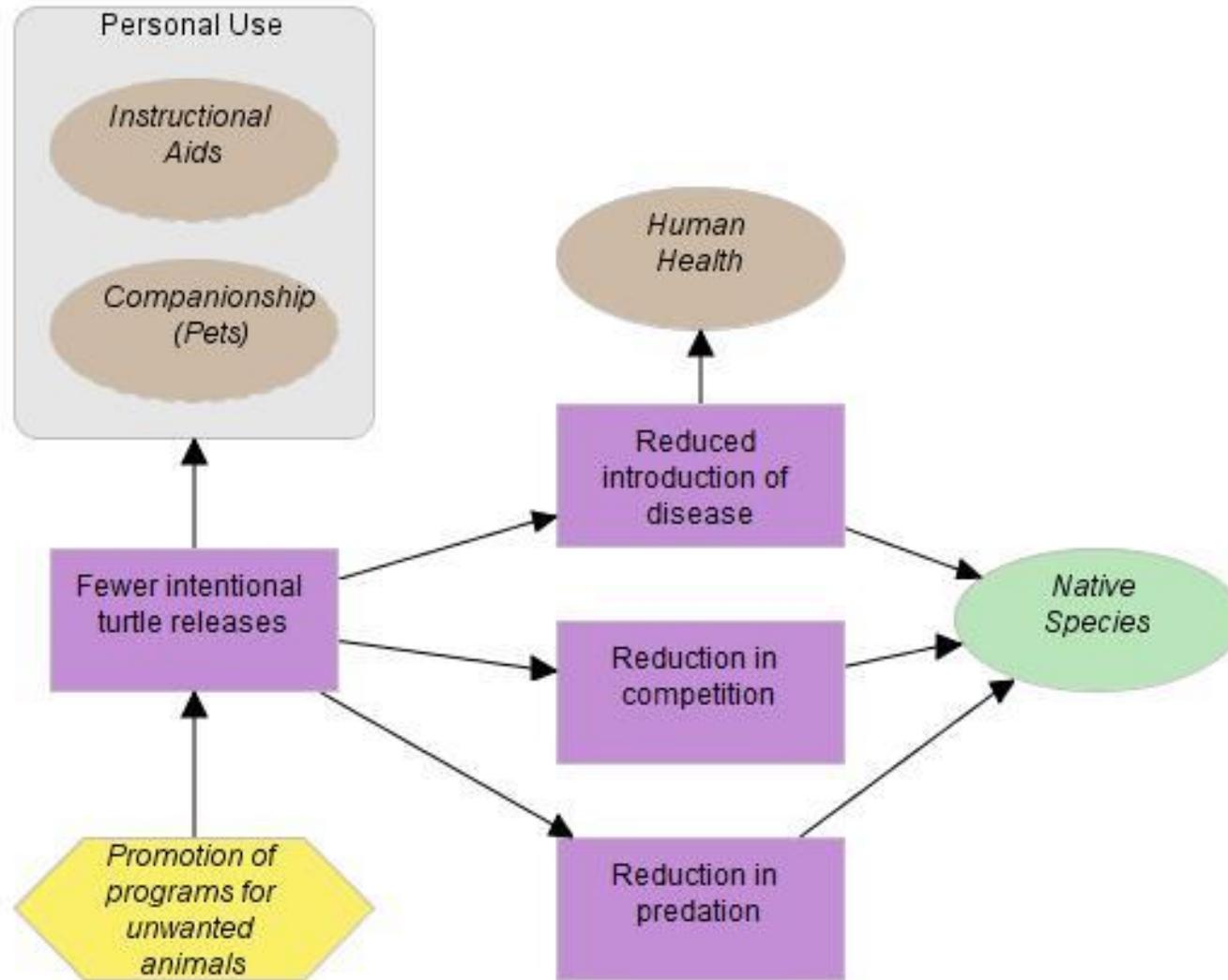




Results Chain: Research into disease dynamics



Results Chain: Promotion of programs for unwanted animals



Industry Notes

Item	Details
 Aquaculture of bullfrogs	<ul style="list-style-type: none"> Likely only viable in the case of an import ban
 Education campaign 1	<ul style="list-style-type: none"> Content: Handling, Releases, Food Safety Venue: Live Markets Audience: retailers
 Education campaign 2	<ul style="list-style-type: none"> Content: Handling, Releases Retail Stores Aimed at prospective pet owners and current pet owners
 Encourage/allow use of other species with lesser effects	<ul style="list-style-type: none"> Jumping frog contest education
 Promotion of programs for unwanted animals	<ul style="list-style-type: none"> CA turtle & tortoise club has people that will take in unwanted turtles and give them for adoption Pet stores also have programs to take back unwanted animals "Don't let it loose" program POS, or when supplies are bought
 Research into population control techniques	<ul style="list-style-type: none"> Triploids
 Online sales	<ul style="list-style-type: none"> Exotic species or special individuals
 Habitat degradation/loss	<ul style="list-style-type: none"> Fragmentation
 Turtles as pets	<ul style="list-style-type: none"> Red-eared sliders
 Loss of genetic diversity	<ul style="list-style-type: none"> Fragmentation in turtles
 Resource loss	<ul style="list-style-type: none"> Food, space, water, plants, breeding sites
 Live markets	<ul style="list-style-type: none"> Consumers don't touch the animals; all are slaughtered before leaving the market Held in regular fish tanks

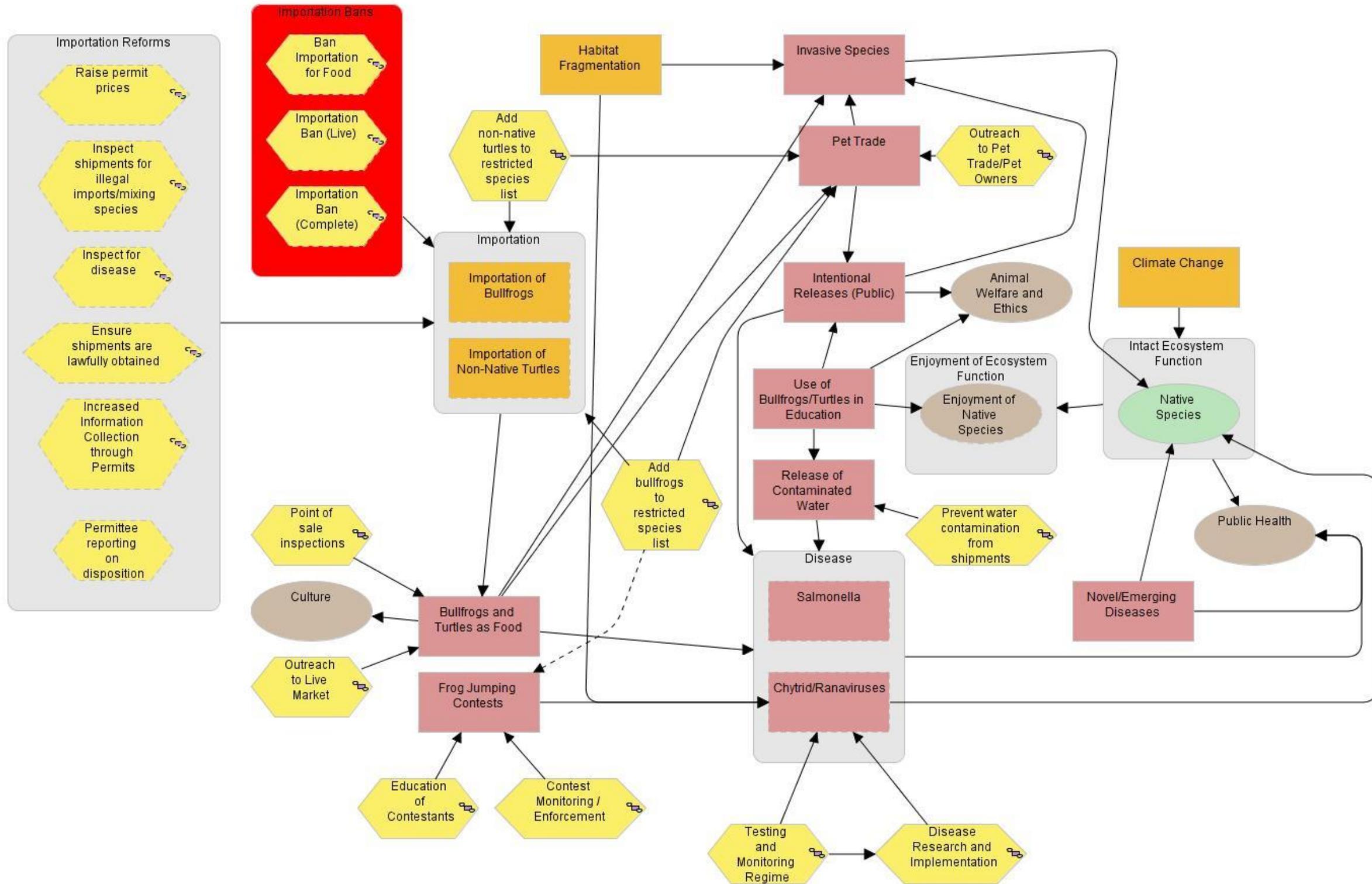
Item	Details
	<ul style="list-style-type: none"> • Water goes into drains that lead to sewers, generally combined with cleaners
<input type="checkbox"/> Specialty store	<ul style="list-style-type: none"> • Farm & feed stores? • Water garden stores
<input type="checkbox"/> Bullfrogs as pets	<ul style="list-style-type: none"> • Does not include tropical species • Prevalence is probably low
<input type="checkbox"/> Human health	<ul style="list-style-type: none"> • USDA 4-inch rule
<input type="radio"/> Commerce and economics	<ul style="list-style-type: none"> • Positive for growers, negative for importers
<input type="radio"/> Companionship (pets)	<ul style="list-style-type: none"> • Pets
<input type="radio"/> Recreation	<ul style="list-style-type: none"> • Frog jumping contests, picture taking of turtles, gigging/fishing for bullfrogs
<input type="checkbox"/> Assurance colonies – Native and non-native species	<ul style="list-style-type: none"> • Not really any licensing, but Captive Bred Wildlife Permit (FWS) allows possession of turtles • When transferring, both parties need a CBW permit • No colonies for red-eared sliders or soft-shelled turtles
<p>-----> Live markets to releases in the wild</p>	<ul style="list-style-type: none"> • This link is disputed
<input type="checkbox"/> Increase Understanding of Adverse Environmental Conditions	<ul style="list-style-type: none"> • Ecological factors that promote or facilitate disease

Environmental/Animal Welfare Group Analysis

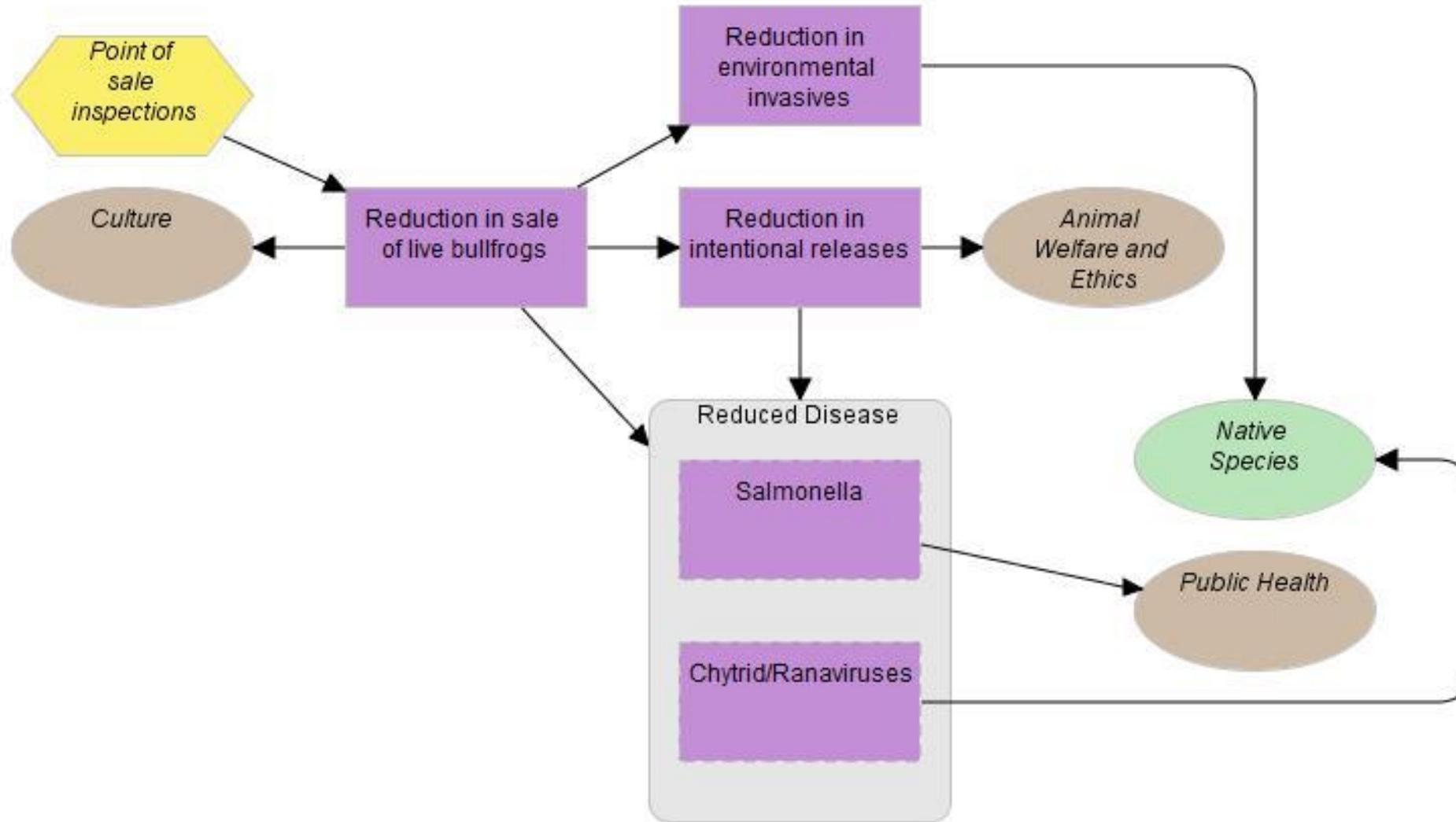
Scope and Vision

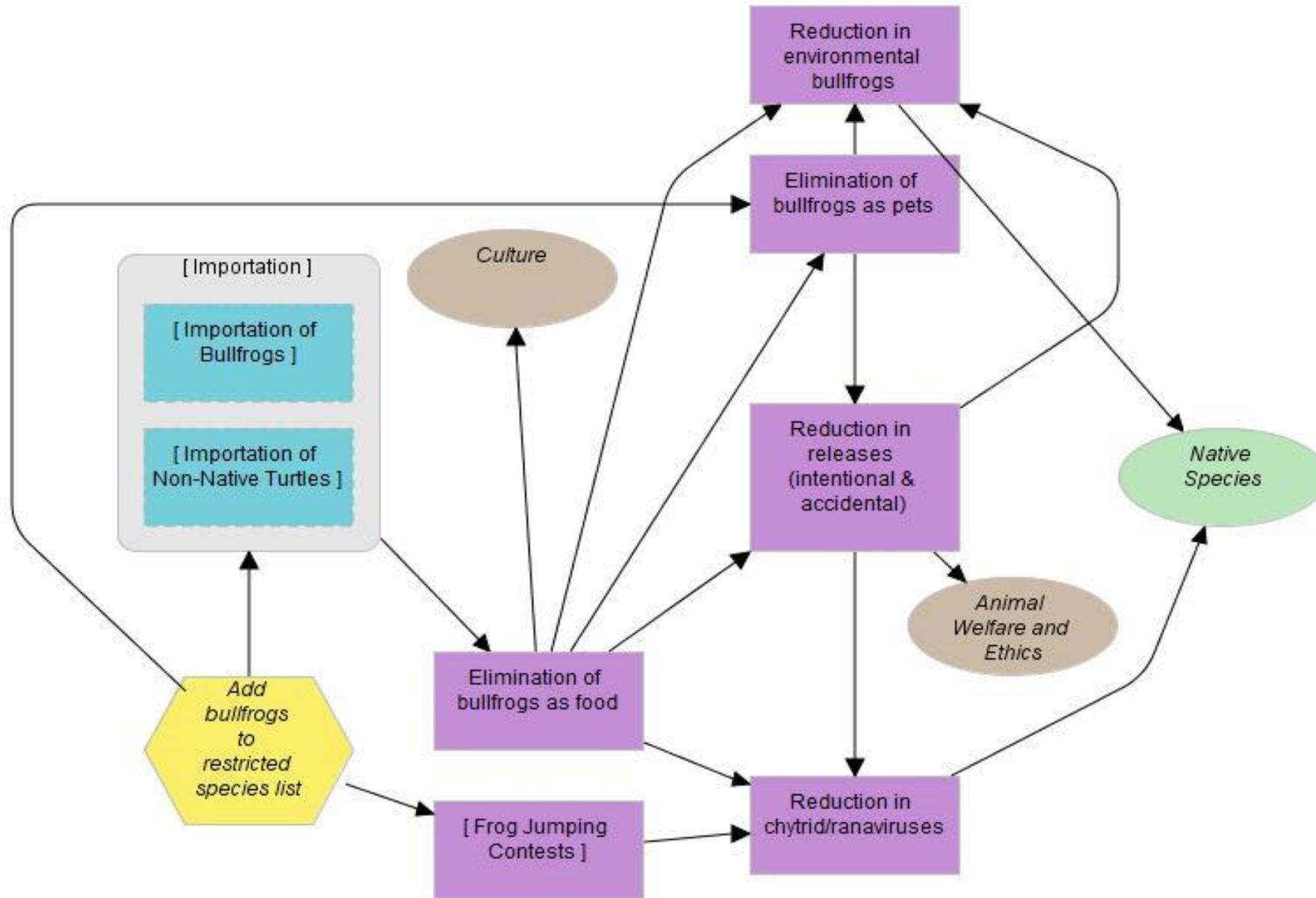
Vision Statement Text	A California with an enforced ban on the importation of bullfrogs and non-native turtles. A Department that lives up to its mission and stated purpose and upholds the public trust.
Comments	

Main Diagram

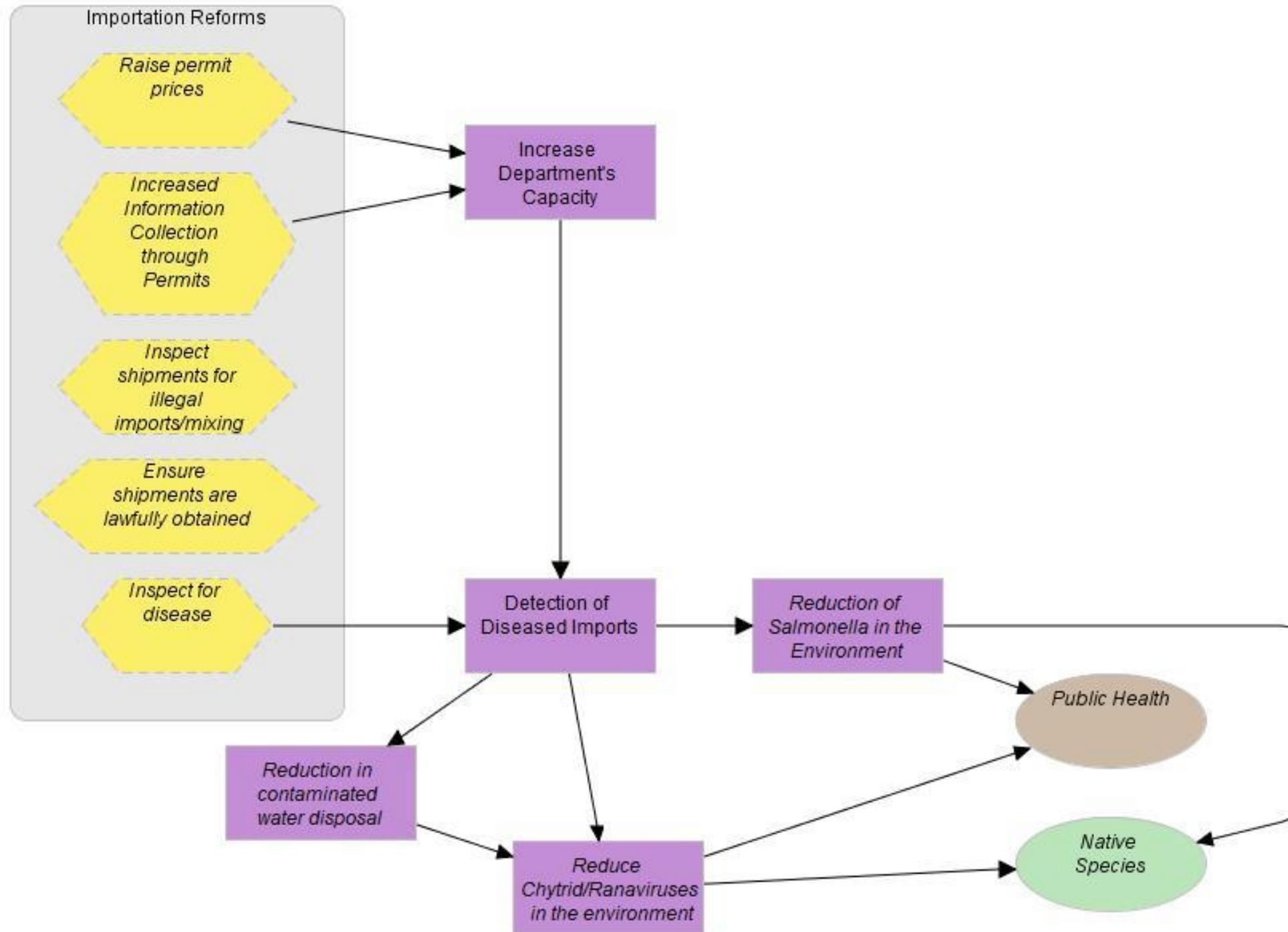


Results Chain: Point of sale inspections

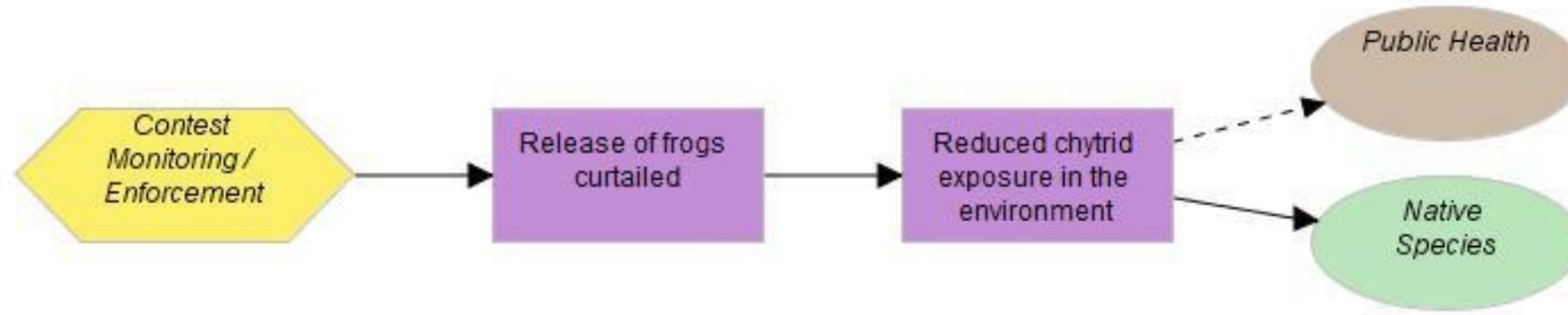




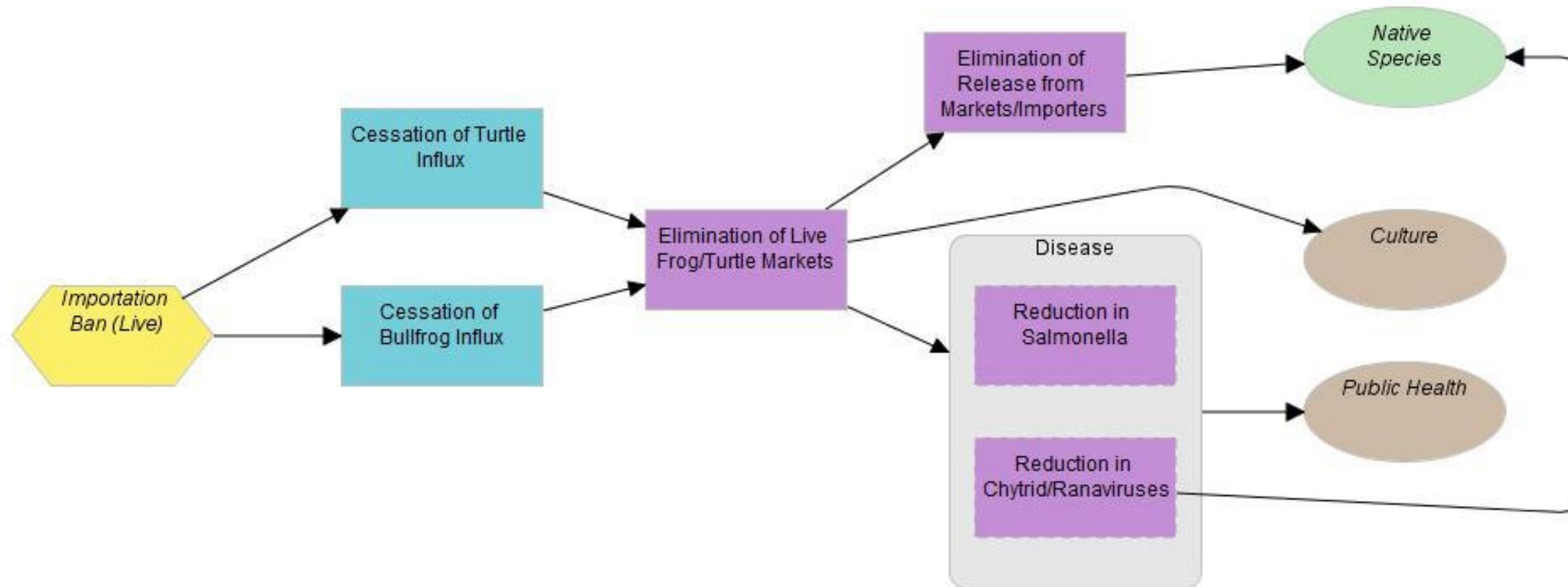
Results Chain: Importation reforms

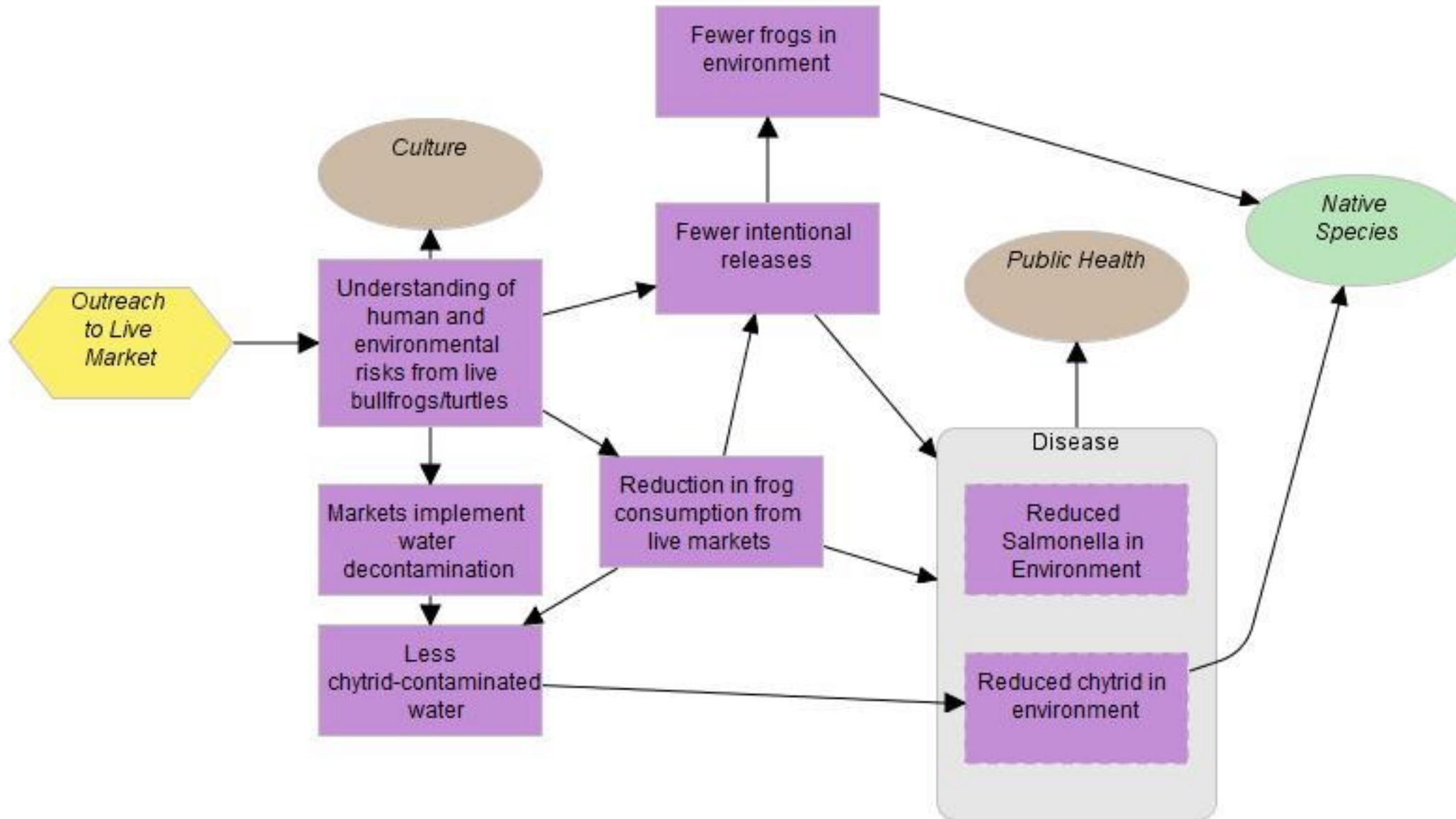


Results Chain: Contest monitoring / enforcement

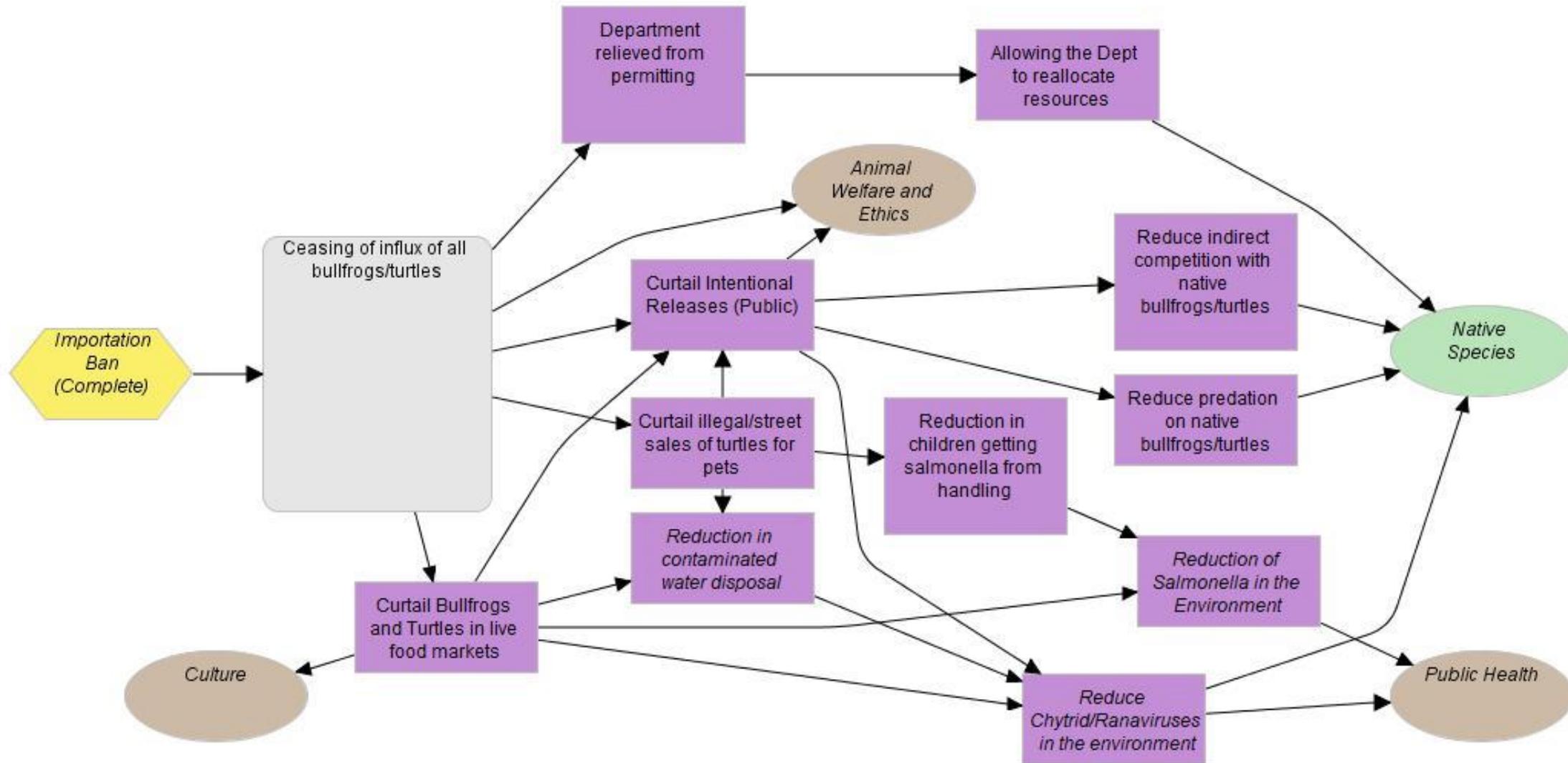


Results Chain: Importation ban (live)

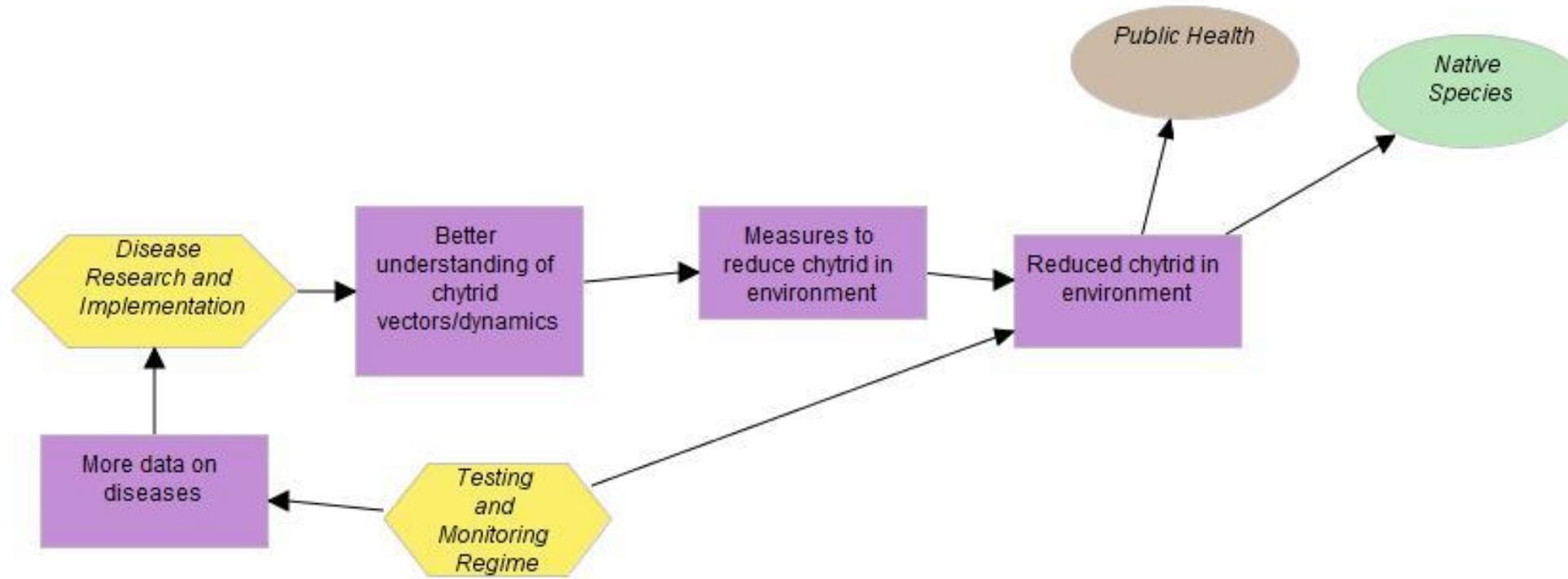




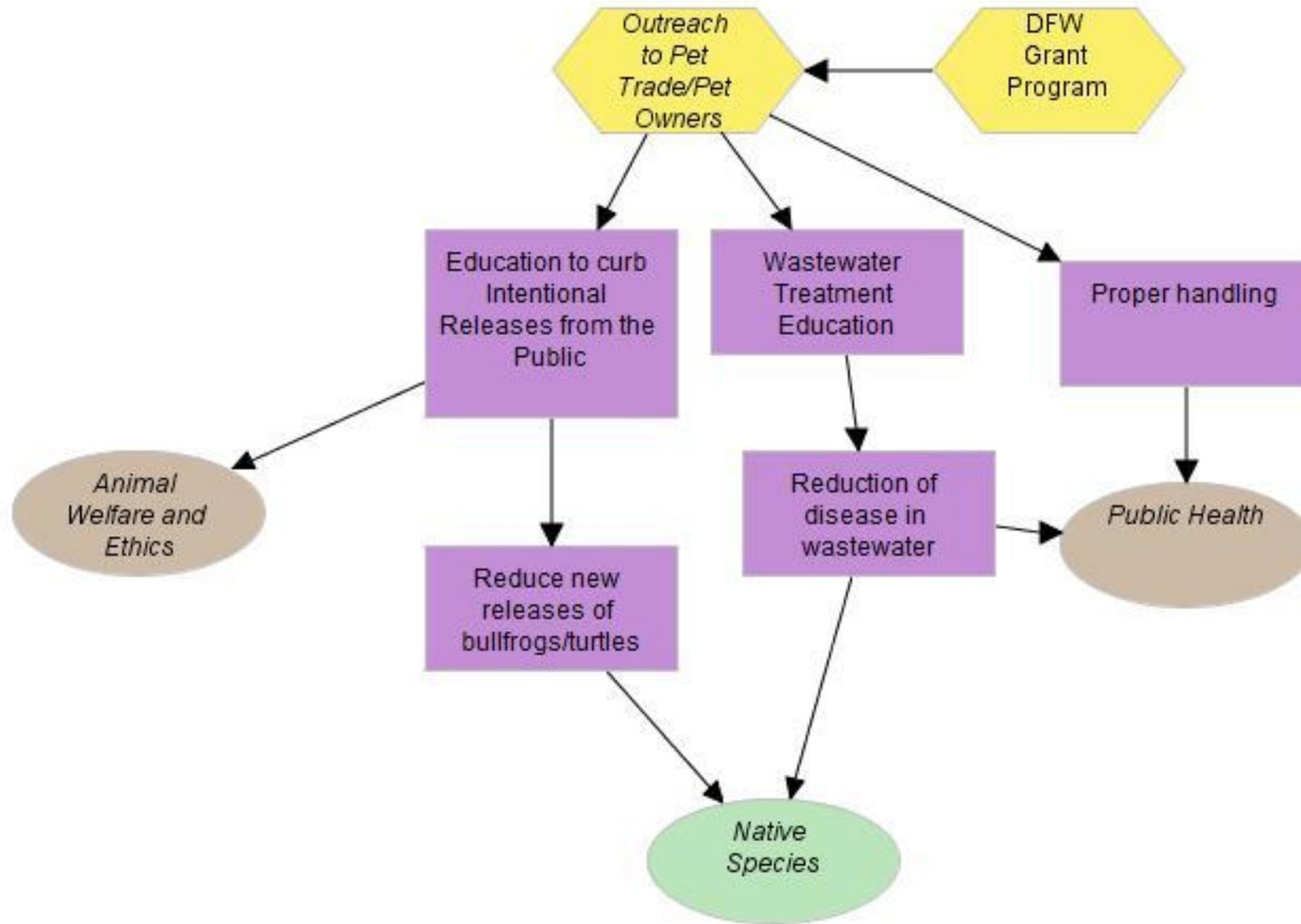
Results Chain: Importation ban (complete)



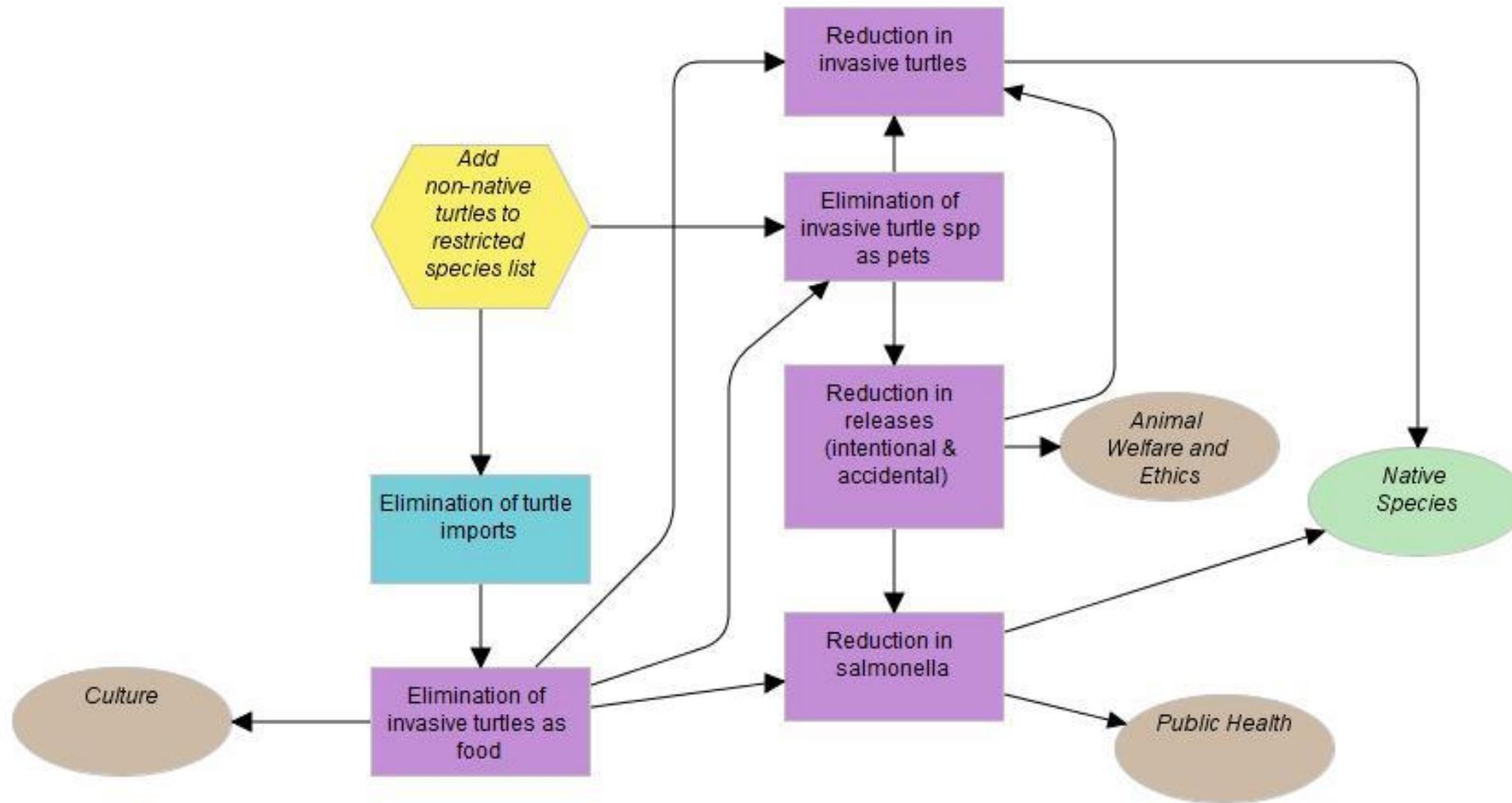
Results Chain: Disease research and implementation



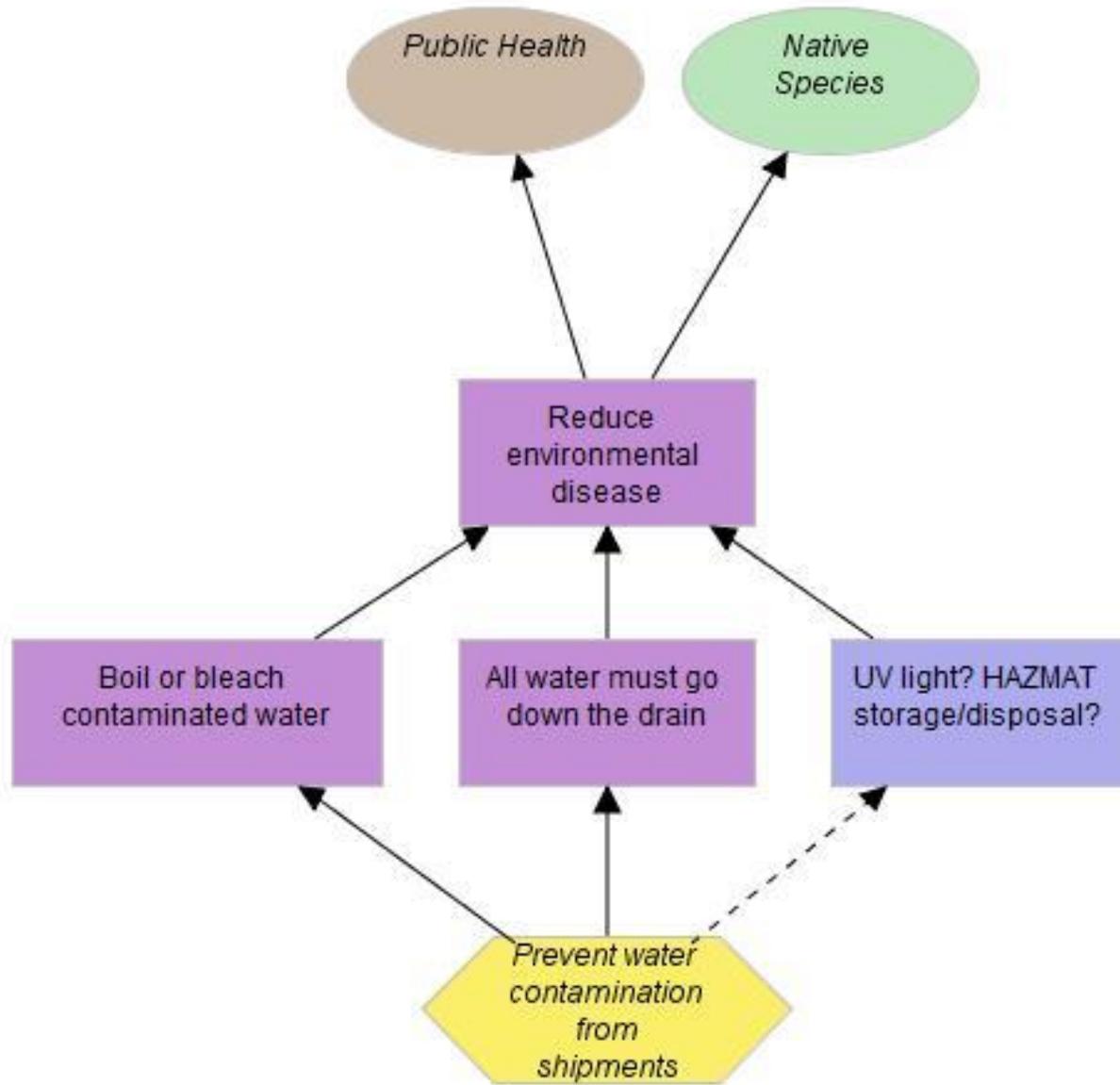
Results Chain: Outreach to pet trade/pet owners



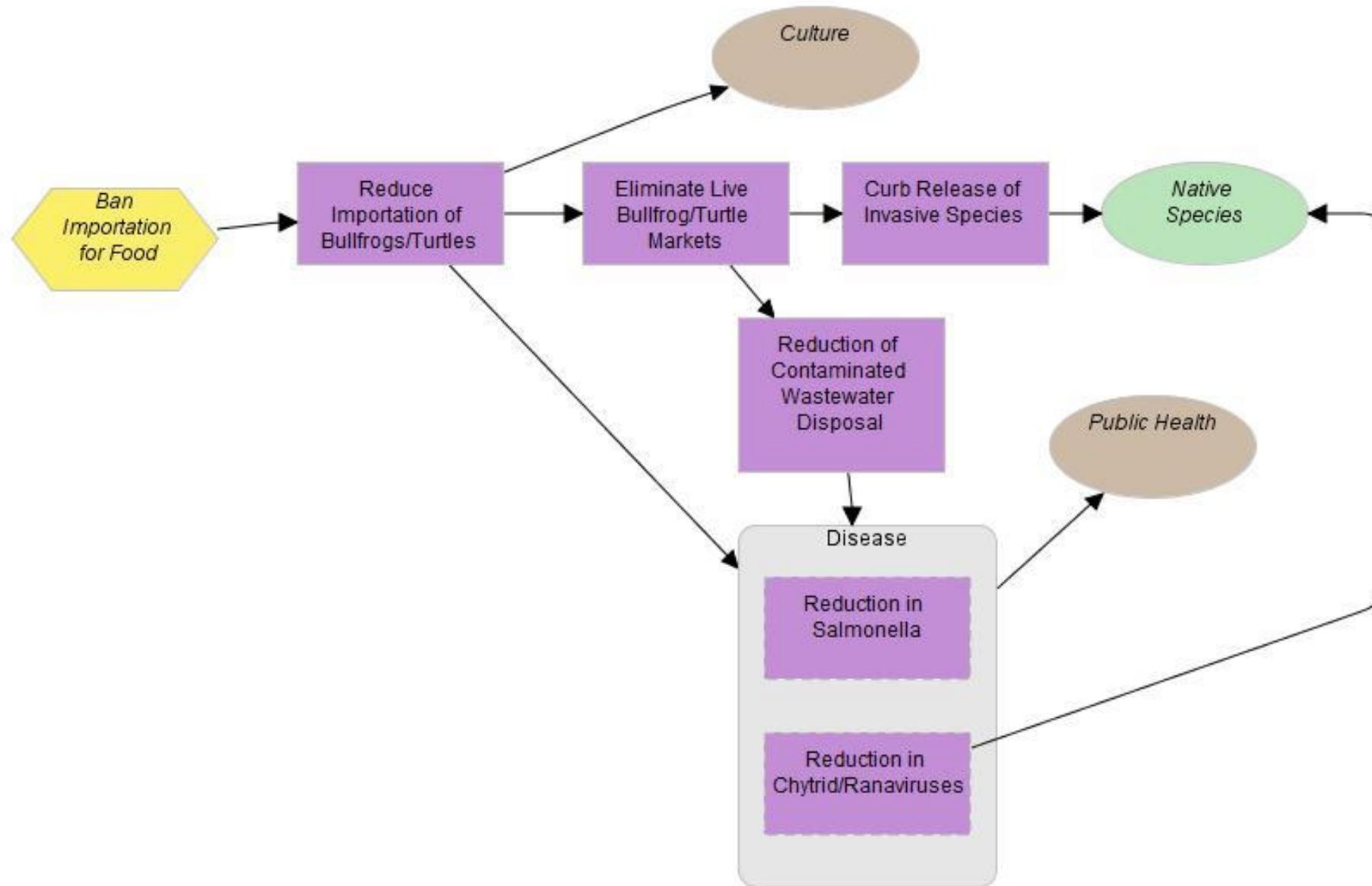
Results Chain: Add non-native turtles to restricted species list



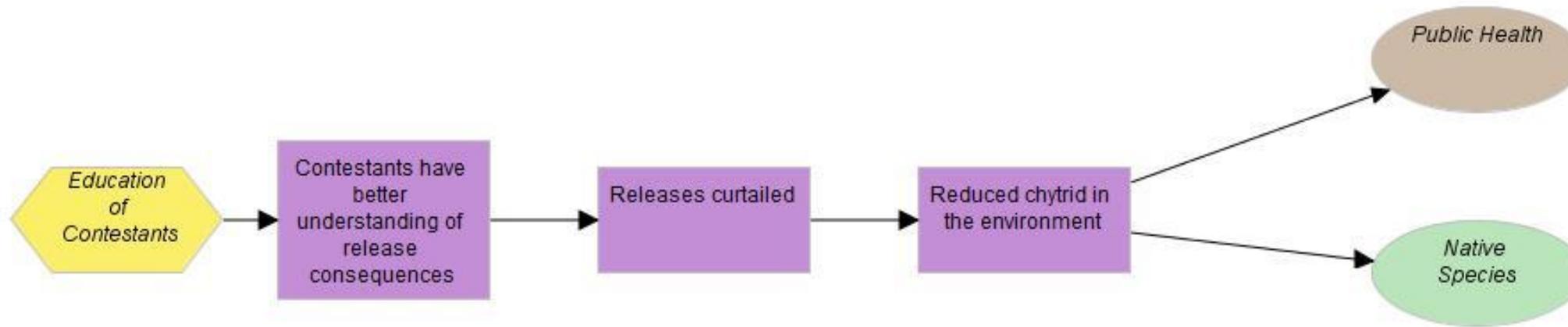
Results Chain: Prevent water contamination from shipments



Results Chain: Ban Importation for food



Results Chain: Education of contestants



Environmental/Animal Welfare Notes

Item	Details
 Add bullfrogs to restricted species list	<ul style="list-style-type: none"> • Could be qualified with certain exceptions
 Add non-native turtles to restricted species list	<ul style="list-style-type: none"> • Could be qualified with certain exceptions
 Testing and Monitoring Regime	<ul style="list-style-type: none"> • Onus could be on the vendor to initiate testing. List of approved testers.
 Ensure shipments are lawfully obtained	<ul style="list-style-type: none"> • See T14, section 236(C)(8) • Pertains to the origin of the shipment. • Perhaps more important for turtles?
 Increased Information Collection through Permits	<ul style="list-style-type: none"> • Where are shipments coming from? How many are you bringing in? Do you have permission from the source?
 Inspect shipments for illegal imports/mixing species	<ul style="list-style-type: none"> • Randomized sample
 Raise permit prices	<ul style="list-style-type: none"> • Price proportional to number of individuals imported? • Permit prices must cover the cost of the DFW bullfrog and turtle program, including inspections and enforcement
 Contest Monitoring / Enforcement	<ul style="list-style-type: none"> • Ensure no use of protected species, information gathering, animal welfare enforcement
 Outreach to Live Market	<ul style="list-style-type: none"> • Shark fin soup – generational • DFW implements, cooperating with SF Library • Could be a comprehensive initiative, should include a contextual component that explains the entire strategy • Importers, retailers • Asian language materials • Benefits of frozen vs. Live animals
 DFW Grant Program	<ul style="list-style-type: none"> • Grant program for organizations to develop education campaigns

Item	Details
 Outreach to Pet Trade/Pet Owners	<ul style="list-style-type: none"> Responsible wastewater treatment
 Point of sale inspections	<ul style="list-style-type: none"> Notice posted? Health and safety codes followed?https://codes.findlaw.com/ca/penal-code/pen-sect-597-3.html
 Prevent water contamination from shipments	<ul style="list-style-type: none"> Distributor to Retailer - Imported water/disposal Transfer water/disposal Market water/disposal
 Novel/emerging diseases	<ul style="list-style-type: none"> Threats to animals or people <i>Batrachochytrium salamandrivorans</i>, plus others that may not be known
 Reduce new releases of bullfrogs/turtles	<ul style="list-style-type: none"> Complications from returned animals? Nominal "rehoming fee"? Education about the reality of keeping/caring for animals before purchase
 Reduction of disease in wastewater	<ul style="list-style-type: none"> Salmonella? Cholera
 Boil or bleach contaminated water	<ul style="list-style-type: none"> Water or ice that has come into contact with frogs/turtles must be boiled or bleached (?%) Boiling is preferred Virkon is an alternative (more expensive)
 Reduce environmental disease	<ul style="list-style-type: none"> Chytrid Some ranaviruses

Appendix B Literature Review

While this annotated literature review collects a number of relevant studies, it does not embody the totality of sources relevant to the topic of the report. References have been selected to present a general overview of relevant material.

Astley, H. C., E. M. Abbott, E. Azizi, R. L. Marsh, and T. J. Roberts. 2013. Chasing maximal performance: a cautionary tale from the celebrated jumping frogs of Calaveras County. *Journal of Experimental Biology* 216:3947–3953.

Details the jump performance of bullfrogs in contests, noting that “professional” frogs jumped farther than “rental” frogs.

Bettelheim, M. P., and W. Wong. 2022. A review of the historical market: effect of the west coast commercial fishery on western pond turtles (*Actinemys marmorata* and *A. pallida*). *Western Wildlife* 9:5–16.

Estimates the historical amounts of western pond turtle catch and sale through the early twentieth century. The study calculates that approximately 524,100 western pond turtles were harvested between 1863 and 1931. Provides historical context to past live markets and the early turtle wildlife trade.

Brunner, J. L., D. M. Schock, E. W. Davidson, and J. P. Collins. 2004. Intraspecific reservoirs: complex life history and the persistence of a lethal ranavirus. *Ecology* 85:560–566.

Demonstrates that ranaviruses can be present in salamanders with only sublethal effects, leading to carriers that may reintroduce the disease to new populations – even small, isolated ones.

Brunner, J. L., K. Richards, and J. P. Collins. 2005. Dose and host characteristics influence virulence of ranavirus infections. *Oecologia* 144:399–406.

Salamander ranavirus virulence varied with dose and among different clutches. Dose did not appear to influence viral clearance. The paper outlines the epidemiological dynamics of viral outbreaks.

Bosch, J., L. M. Carrascal, L. Durán, S. Walker, and M. C. Fisher. 2007. Climate change and outbreaks of amphibian chytridiomycosis in a montane area of Central Spain; is there a link? *Proceedings of the Royal Society B: Biological Sciences* 274:253–260.

Warming temperatures due to climate change may exacerbate chytrid outbreaks due to shorter, milder winters.

Campbell, T., B. Shaw, E. Hammond, L. Bao, S. Yang, P. Jurich, and S. Fox. 2021. Qualitative interviews of practitioners of Buddhist life release rituals residing in the United States: implications for reducing invasion risk. *Management of Biological Invasions* 12:178–192.

Details the practice of releasing live animals into the environment as a spiritual practice. California is among the locations studied. Turtles are mentioned as a possible animal to be released, though fish are the only species specifically mentioned as being released in California. Participants emphasized saving the lives of animals versus simply releasing

animals. Sources included pet stores, bait shops, markets, commercial anglers, and wildlife rehabilitation centers. Many interviewees were aware of invasive species issues.

Claytor, S. C., K. Subramaniam, N. Landrau-Giovannetti, V. G. Chinchar, M. J. Gray, D. L. Miller, C. Mavian, M. Salemi, S. Wisely, and T. B. Waltzek. 2017. Ranavirus phylogenomics: Signatures of recombination and inversions among bullfrog ranaculture isolates. *Virology* 511:330–343.

Genetically characterizes different bullfrog ranavirus strains. Underscores the bullfrog as a vector for ranaviruses.

Cook, D. G., and A. F. Currylow. 2013. Seasonal spatial patterns of two sympatric frogs: California red-legged frog and American bullfrog. *Western Wildlife* 1:1–7.

Explores the spatial dynamics by which bullfrogs outcompete California red-legged frogs.

Crowley, S. L., S. Hinchliffe, and R. A. McDonald. 2017. Invasive species management will benefit from social impact assessment. *Journal of Applied Ecology* 54:351–357.

Urges deliberative, participatory approaches to invasive species management by identifying, evaluating and addressing social costs and benefits.

De Voe, R., K. Geissler, S. Elmore, D. Rotstein, G. Lewbart, and J. Guy. 2004. Ranavirus-associated morbidity and mortality in a group of captive eastern box turtles (*Terrapene carolina carolina*). *Journal of Zoo and Wildlife Medicine* 35:534–543.

Reviews the clinical progression of ranavirus in seven box turtles. Attempted treatments did not alter the course of the disease.

Garwood, J. M., S. J. Ricker, and C. W. Anderson. 2010. Bullfrog Predation on a Juvenile Coho Salmon in Humboldt County, California. *Northwestern Naturalist* 91:99–101.

Details an occurrence of a bullfrog having eaten a juvenile coho salmon.

Gray, I. A. 2009. Breeding pond dispersal of interacting California red-legged frogs (*Rana draytonii*) and American bullfrogs (*Lithobates catesbeianus*) of California: a mathematical model with management strategies. M.S. Thesis, Humboldt State University, Arcata, CA. <<http://humboldt-dspace.calstate.edu/handle/2148/560>>. Accessed 10 Feb 2014.

Models the dynamics of California red-legged frogs and bullfrogs. Explores cases where co-occurrence could occur, and provides recommendations to enhance California red-legged frog persistence.

Greer, A. L., M. Berrill, and P. J. Wilson. 2005. Five amphibian mortality events associated with ranavirus infection in south central Ontario, Canada. *Diseases of aquatic organisms* 67:9.

Examines an outbreak of ranavirus in three Canadian amphibian populations.

Harp, E. M., and J. W. Petranka. 2006. Ranavirus in wood frogs (*Rana sylvatica*): potential sources of transmission within and between ponds. *Journal of Wildlife Diseases* 42:307–318.

Examines ranavirus transmission factors and survival rates of tadpoles. In outdoor wading pool experiments, near total dieoffs occurred regardless of initial tadpole density. Other experiments indicated the presence of sublethal effects.

Hartmann, A. M., M. L. Maddox, R. J. Ossiboff, and A. V. Longo. 2022. Sustained ranavirus outbreak causes mass mortality and morbidity of imperiled amphibians in Florida. *EcoHealth* 19:8–14.

In some circumstances ranaviruses can lead to large-scale amphibian dieoffs. Various species can exhibit differential susceptibility and some hosts may serve as reservoirs for pathogenesis. The authors recommend that disease surveillance and pathogen mitigation strategies be developed.

Heard, G. W., M. P. Scroggie, D. S. L. Ramsey, N. Clemann, J. A. Hodgson, and C. D. Thomas. 2018. Can habitat management mitigate disease impacts on threatened amphibians? *Conservation Letters* 11:e12375.

Habitat restoration and management can be conducted to attenuate the effects of chytrid disease. Models of habitat creation and management demonstrated infection prevalence reductions as high as 34 percent and reduced metapopulation extinction rates up to 80 percent in some cases. Creating habitat with refugial properties can be more effective than enhancing existing habitat.

Hyatt, A. D., M. Williamson, B. E. H. Coupar, D. Middleton, S. G. Hengstberger, A. R. Gould, P. Selleck, T. G. Wise, J. Kattenbelt, A. A. Cunningham, and others. 2002. First identification of a ranavirus from green pythons (*Chondropython viridis*). *Journal of Wildlife Diseases* 38:239–252.

Presents the first documentation of ranavirus in a snake species.

Implications of importing American bullfrog (*Lithobates catesbeianus* = *Rana catesbeiana*) into California. 2014. California Department of Fish and Wildlife.

A comprehensive analysis of bullfrog biology and ecology in California, as well as an analysis of bullfrog importation and the threats it poses to California's wildlife populations.

Johnson, M. L., and R. Speare. 2003. Survival of *Batrachochytrium dendrobatidis* in water: quarantine and disease control implications. *Emerging Infectious Diseases* 9:915–921.

Chytrid fungus (*Batrachochytrium dendrobatidis*, or Bd) has inhibited growth in tap, lake, and distilled water over ideal laboratory conditions. Bd did not release zoospores in tap and deionized water. Zoospores may persist in the environment in a state of arrested development for long time periods (3-4 weeks).

Johnson, M., L. Berger, L. Philips, and R. Speare. 2003. Fungicidal effects of chemical disinfectants, UV light, desiccation and heat on the amphibian chytrid *Batrachochytrium dendrobatidis*. *Diseases of Aquatic Organisms* 57:255–260.

Chemical disinfectants including sodium chloride, household bleach (active ingredient: sodium hypochlorite), potassium permanganate, formaldehyde solution, Path-XTM agricultural disinfectant (active ingredient: didecyl dimethyl ammonium chloride, DDAC), quaternary ammonium compound 128 (DDAC), Dithane, Virkon, ethanol and benzalkonium chloride were tested, as well as sterilizing ultraviolet (UV) light, and heat and desiccation, to test the efficacy of water sterilization of *Batrachochytrium dendrobatidis*. All compounds had some degree of effectiveness, but those containing DDAC were most effective and can

be deployed at low concentrations. Heating and drying met with some success but UV was ineffective.

Johnson, M., and R. Speare. 2005. Possible modes of dissemination of the amphibian chytrid *Batrachochytrium dendrobatidis* in the environment. *Diseases of Aquatic Organisms* 65:181–186.

Demonstrates *Batrachochytrium dendrobatidis* survival and potential ability for translocation in moist river sand and in bird feathers.

Kamoroff, C., N. Daniele, R. L. Grasso, R. Rising, T. Espinoza, and C. S. Goldberg. 2019. Effective removal of the American bullfrog (*Lithobates catesbeianus*) on a landscape level: long term monitoring and removal efforts in Yosemite Valley, Yosemite National Park. *Biological Invasions*. <<https://doi.org/10.1007/s10530-019-02116-4>>. Accessed 30 Oct 2019.

Documents successful eradication of bullfrogs on a landscape level at Yosemite National Park.

Kim, R., B. J. Halstead, E. J. Routman, and J. Andersen. 2021. When introduced prey violates trophic hierarchy: Conservation of an endangered predator. *Biological Conservation* 256:109019.

Explores the dynamics between bullfrogs and the imperiled San Francisco garter snake. Notes that localized bullfrog control efforts can be critical in the conservation of many such species.

Lambert, M. R., J. M. McKenzie, R. M. Screen, A. G. Clause, B. B. Johnson, G. G. Mount, H. B. Shaffer, and G. B. Pauly. 2019. Experimental removal of introduced slider turtles offers new insight into competition with a native, threatened turtle. *PeerJ* 7:e7444.

Recounts a field experiment of the limited removal of red-eared sliders, and measured the responses of western pond turtles. Demonstrates intense competition for basking and potentially other resources such as food.

Lips, K. R., J. Diffendorfer, J. R. Mendelson III, and M. W. Sears. 2008. Riding the wave: reconciling the roles of disease and climate change in amphibian declines. *PLoS Biology* 6:e72.

Modelling of South and Central American amphibian populations found no evidence that climate change is driving chytrid fungal outbreak, but reveals important aspects of disease spread.

Louette, G. 2012. Use of a native predator for the control of an invasive amphibian. *Wildlife Research* 39:271–278.

Predatory fish can be effective in control of bullfrog tadpoles. Both direct (predation) and indirect (increase in predation by macroinvertebrates) on tadpoles may be operative.

Louette, G., S. Devisscher, and T. Adriaens. 2014. Combating adult invasive American bullfrog *Lithobates catesbeianus*. *European Journal of Wildlife Research* 60:703–706.

Demonstrates that double fyke nets can be effective in bullfrog removal. McMahon, T. A., B. F. Sears, M. D. Venesky, S. M. Bessler, J. M. Brown, K. Deutsch, N. T. Halstead, G. Lentz,

N. Tenouri, S. Young, D. J. Civitello, N. Ortega, J. S. Fites, L. K. Reinert, L. A. Rollins-Smith, T. R. Raffel, and J. R. Rohr. 2014. Amphibians acquire resistance to live and dead fungus overcoming fungal immunosuppression. *Nature* 511:224–227.

Amphibians can acquire immunoresistance to Bd pathogens through behavioral adaptation or exposure to either live or dead fungus.

Nicholson, E. G., S. Manzo, Z. Devereux, T. P. Morgan, R. N. Fisher, C. Brown, R. Dagit, P. A. Scott, and H. B. Shaffer. 2020. Historical museum collections and contemporary population studies implicate roads and introduced predatory bullfrogs in the decline of western pond turtles. *PeerJ* 8:e9248.

Examination of historical museum specimens indicates negative effects of roads and bullfrogs in the decline of western pond turtle species. Male-biased sex ratios indicate a strong negative effect from roads, while long-term changes in body size implicate competition and predation from non-native invasive species.

Open Standards for the Practice of Conservation. 2020. Conservation Measures Partnership. <<https://conservationstandards.org/download-cs/>>.

A manual explaining the *Open Standards for the Practice of Conservation*, the process used to examine the issues surrounding bullfrogs and non-native turtles.

Pearman, P. B., T. W. Garner, M. Straub, and U. F. Greber. 2004. Response of the Italian agile frog (*Rana latastei*) to a ranavirus, frog virus 3: a model for viral emergence in naive populations. *Journal of Wildlife Diseases* 40:660–669.

Describes lab experiments to determine the transmission and survival of a North American strain (FV3) on ranavirus on tadpoles. Different populations may have varying susceptibility to the pathogen and in response to varying levels of ecological community complexity and other environmental factors.

Pounds, J. A., M. R. Bustamante, L. A. Coloma, J. A. Consuegra, M. P. Fogden, P. N. Foster, E. La Marca, K. L. Masters, A. Merino-Viteri, and R. Puschendorf. 2006. Widespread amphibian extinctions from epidemic disease driven by global warming. *Nature* 439:161–167.

Posits a link between chytrid epidemics implicated in previous Central American amphibian extinctions and large-scale warming associated with climate change.

Ribeiro, L. P., T. Carvalho, C. G. Becker, T. S. Jenkinson, D. da S. Leite, T. Y. James, S. E. Greenspan, and L. F. Toledo. 2019. Bullfrog farms release virulent zoospores of the frog-killing fungus into the natural environment. *Scientific Reports* 9:1–10.

Bullfrog farms can harbor *Batrachochytrium dendrobatidis* (Bd) and release it into the environment, and can have high prevalence and pathogen loads. High densities may play a role in increasing frog susceptibility, and tadpoles may serve as a reservoir for Bd. They posit that controlling chytrid in farms may increase profits. They advocate for treating both frogs and water.

Rojas, S., K. Richards, J. K. Jancovich, and E. W. Davidson. 2005. Influence of temperature on Ranavirus infection in larval salamanders *Ambystoma tigrinum*. *Diseases of aquatic organisms* 63:95–100.

Demonstrates that temperature strongly affects the infectiousness, percent mortality, and time-to-death of salamanders infected with ranavirus.

Salafsky, N., R. Margoluis, K. H. Redford, and J. G. Robinson. 2002. Improving the practice of conservation: a conceptual framework and research agenda for conservation science. *Conservation Biology* 16:1469–1479.

Provides the conceptual underpinnings of the *Open Standards for the Practice of Conservation* and how to use the framework to effect positive conservation action.

Salafsky, N., and E. Wollenberg. 2000. Linking livelihoods and conservation: a conceptual framework and scale for assessing the integration of human needs and biodiversity. *World development* 28:1421–1438.

Discusses the integration of human well-being targets into the *Open Standards for the Practice of Conservation*.

Schloegel, L. M., A. M. Picco, A. M. Kilpatrick, A. J. Davies, A. D. Hyatt, and P. Daszak. 2009. Magnitude of the US trade in amphibians and presence of *Batrachochytrium dendrobatidis* and ranavirus infection in imported North American bullfrogs (*Rana catesbeiana*). *Biological Conservation* 142:1420–1426.

An examination of bullfrogs obtained from live markets in Los Angeles, San Francisco, and New York found a 62% prevalence of *Batrachochytrium dendrobatidis* (Bd) and an 8.5% prevalence of ranaviruses. California markets had a lower probability of Bd infection than New York, but LA frogs had a higher chance of ranavirus than elsewhere. The study found significant seasonal differences in probability of infection (winter > summer > spring). There was no correlation between prevalence of the two diseases.

Schwartz, M. W., K. Deiner, T. Forrester, P. Grof-Tisza, M. J. Muir, M. J. Santos, L. E. Souza, M. L. Wilkerson, and M. Zylberberg. 2012. Perspectives on the open standards for the practice of conservation. *Biological Conservation* 155:169–177.

Setting free the fish. n.d. Global Times.

A review of the *Open Standards for the Practice of Conservation*, including an examination of its strengths and suitability for approaching a wide variety of conservation planning tasks.

Snow, N., P., and G. Witmer. 2010. American bullfrogs as invasive species: a review of the introduction, subsequent problems, management options, and future directions. Pages 86–89 in R. M. Timm and K. A. Fagerstone, editors. *Proceedings of the Vertebrate Pest Conference*. Volume 24. University of California Davis, Davis, CA. <<https://escholarship.org/uc/item/5j46t7f2>>.

A general review of bullfrogs and their impacts. Mentions several chemical control methods and a floating live multiple capture trap. The trap can facilitate easy release of non-target species.

Snow, N. P., and G. W. Witmer. 2011. A field evaluation of a trap for invasive American bullfrogs. *Pacific Conservation Biology* 17:285.

Details a successful method of capturing bullfrogs using a floating multiple capture trap.

Stromberg, J. 2013. The science of winning leaps at the Calaveras County frog jumping competition. *Smithsonian*. <<https://www.smithsonianmag.com/science-nature/the-science-of-winning-leaps-at-the-calaveras-county-frog-jumping-competition-2277694/>>. Accessed 17 Jun 2019.

Expounds on how bullfrogs are able to perform well in jumping frog contests and why bullfrogs are a preferred species.

Wang, H., C. Yang, Z. Sun, W. Zheng, W. Zhang, H. Yu, Y. Wu, X. Didelot, R. Yang, J. Pan, and Y. Cui. 2020. Genomic epidemiology of *Vibrio cholerae* reveals the regional and global spread of two epidemic non-toxigenic lineages. *PLOS Neglected Tropical Diseases* 14:e0008046.

Examines the genetics and epidemiology of an outbreak of *Vibrio cholerae* bacteria in humans, linked to soft-shelled turtles and bullfrogs.

West, D. 1997. Buddhists release animals, dismaying wildlife experts. *The New York Times*, 11 January 1997; section New York. <<https://www.nytimes.com/1997/01/11/nyregion/buddhists-release-animals-dismaying-wildlife-experts.html>>. Accessed 27 Aug 2021.

Describes the practice of releasing animals in New York, including turtles, for cultural and spiritual ceremonies, and the environmental damage it can cause. Details the purposes for the practices, such as the motivation to show respect for life and do good acts.

Wilgen, N. J. van, M. S. Gillespie, D. M. Richardson, and J. Measey. 2018. A taxonomically and geographically constrained information base limits non-native reptile and amphibian risk assessment: a systematic review. *PeerJ* 6:e5850.

A review of research papers on herpetological invasive species, highlighting several taxonomic, geographic and subject patterns and biases of publications.

Woodburn, D. B., A. N. Miller, M. C. Allender, C. W. Maddox, and K. A. Terio. 2019. *Emydomyces testavorans*, a new genus and species of Onygenalean fungus isolated from shell lesions of freshwater aquatic turtles. *Journal of Clinical Microbiology* 57. <<https://jcm.asm.org/content/57/2/e00628-18>>. Accessed 3 Aug 2020.

Describes a fungus previously found only in reptiles but recently found in various aquatic turtle species, including some that can be found in California.

Yang, Y., X. Zhu, H. Zhang, Y. Chen, Y. Liu, Y. Song, and X. Ai. 2022. *Vibrio cholerae* was found in cultured bullfrog. *Epidemiology and Infection* 150:e30.

A study of “anorectal disease” which isolates and identifies *V. cholerae* bacteria in bullfrogs. Examines the pathogenicity and potential treatments.

Yap, T. A., M. S. Koo, R. F. Ambrose, and V. T. Vredenburg. 2018. Introduced bullfrog facilitates pathogen invasion in the western United States. M. C. Fisher, editor. PLOS ONE 13:e0188384.

Uses museum specimens to examine the invasion history and disease dynamics of *Batrachochytrium dendrobatidis* (Bd). Creates a suitability model to glean the historical spread of Bd across the US and link it to the proliferation of bullfrogs.