UTAH BEAVER MANAGEMENT PLAN

Developed in consultation with
BEAVER ADVISORY COMMITTEE

DWR Publication 17-20

Utah Division of Wildlife Resources
1594 West North Temple
Salt Lake City, Utah 84114

Approved by the Wildlife Board January 6, 2010
Revised May, 2017

2010 BEAVER ADVISORY COMMITTEE MEMBERS

Group Members
Stan Bassett   Utah Trappers Association
Steve Flinders   U.S. Forest Service
Karen Fullen   Natural Resource Conservation Service
Darrell Johnson   Utah Cattlemen's Association
John Keeler   Utah Farm Bureau
Mary O'Brien   Grand Canyon Trust
Darren Williams   Bureau of Land Management
Jared Zierenberg   U.S.D.A., Wildlife Services

Division of Wildlife Resources Representatives
Kevin Bunnell   Mammals Coordinator
Justin Dolling   Game Mammals Coordinator
Steve Gray   Wildlife Specialist
Craig Walker   Aquatic Habitat Coordinator
Alison Whittaker   Wildlife Habitat Biologist

Contents

UTAH BEAVER MANAGEMENT PLAN

Plan Goal

Maintain healthy, functional beaver populations in ecological balance with available habitat, human needs, and associated species.

INTRODUCTION

The purpose of the Utah Beaver Management Plan is to provide direction for management of American beaver (*Castor canadensis*) in Utah and where appropriate expand the current distribution to historic range. This purpose is in accordance with the mission statement of the Utah Division of Wildlife Resources (UDWR). The mission of UDWR is:

> *To serve the people of Utah as trustee and guardian of the state's wildlife*

The Beaver Management Plan will direct beaver management statewide. This document will be reviewed, management progress will be evaluated and an updated management plan will be written and presented to the Utah Wildlife Board for approval periodically as needs are identified or new research is conducted.

BACKGROUND

Natural History

Beaver are the largest member of the rodent order in North America, and belong to the family Castoridae. They are very adapted to aquatic environments, with webbed feet, a stout body and broad paddle like tail to aid in swimming and balancing when standing upright. On land beaver move with an awkward waddle but are capable of bolting short distances. Adult beaver weigh 16-31.5 kg (35-70 lbs) and are up to 120 cm (47 in) in length (Baker and Hill, 2003). Pelt coloration varies from reddish, chestnut, nearly black to a yellowish brown depending on the population.

Beaver reach sexual maturity between 1.5-3 years of age (Baker and Hill, 2003). They are considered monogamous with a single pair and young forming a family group. Extended family members form a loose knit group referred to in the literature as a colony. A typical colony consists of an adult pair, young of the year or kits and yearlings from the previous year. Beaver breed in the fall and early winter and give birth to one litter (typically 2-4 young) in the spring. The gestation period is approximately 100 days. Young stay with the adults through the first winter and as yearlings during the second winter. Dispersal usually occurs at 24 months of age but is variable depending on the amount of unoccupied habitat.

Beavers are believed to exhibit density dependent population characteristics (Barker et. al. 2003). Home range can vary 8-18 ha (20-45 ac) with nonfamily groups tending to occupy larger territories than family groups (Wheatley, 1997a; Wheatley, 1997b; Wheatley, 1997c).

Beaver construct dams, ponds and canals to gain reliable access to food resources. This activity tends to alter the adjoining landscape. In addition, beaver construct lodges and bank dens for shelter and protection from predators. Within these newly created aquatic systems, beaver may establish winter food caches. This behavior usually occurs only in regions with persistent ice cover during a portion of the year. Beaver consume both herbaceous and woody plants with studies documenting 0.5-2.0 kg (1-4.5 lbs) of wet woody forage per day (Dyck and Macarthur, 1993). Their preferred diet, when present, consists of herbaceous vegetation (forbs, grasses, roots and tubers), aspen, cottonwood and willow (Jenkins, 1981). Other woody plants found in their diet but less desirable, like conifers, sage brush and tamarisk are used for dam construction and the capping of winter food caches.

Distribution and Abundance

Beaver are native to North America and found throughout most of Utah. Durrant (1952) described beaver inhabiting all regions of Utah, except the desert environments of the Great Basin. Early Utah explorers and fur trappers considered beaver abundant prior to 1825 (Rawley, 1985). Aggressive trapping continued into the late 1800's until beaver were considered rare. Beaver harvest was closed by the state legislature in 1899.

By 1912 beaver populations were increasing and nuisance activities were reported. Beginning in 1915, Utah citizens could live trap up to 10 beaver per year for propagation provided 25% of the progeny were released back into the wild. In 1937, thirty caretakers (trappers) live trapped and transplanted 84 beaver onto National Forest Lands. Statewide harvest resumed in 1957, with occasional site specific closures, likely due to an increase in beaver distribution and abundance.

The predicted beaver habitat in Utah was mapped as part of the 1995 Utah GAP Analysis (Figure 1). However, this mapping is based on general assumptions and habitat suitability models do not generally discriminate well for generalists like beaver. In simple terms, beaver need woody and herbaceous plants for forage and deep enough water to maintain under water entrances to their lodges and provide cover from predators. The UDWR conducted a beaver distribution, habitat and population survey from 1971-1982. This survey estimated 4,021 miles (6,471 km) of suitable stream habitat with a carrying capacity of 25,492 beaver statewide (Blackwell and Pederson, 1993). The population in 1981 was estimated at 29,445 beavers (Blackwell and Pederson, 1993). By contrast, more recent estimates by Macfarlane et al. (2014, pp 89-91) conservatively estimate that at least 15,000 miles (24,140 km) of perennial streams in Utah can support dam building activity by beaver (Figure 2). This does not include intermittent streams they sometimes build dams in, nor consider habitat along deeper rivers and 80 that can support beaver in the absence of beaver dam building. Macfarlane et al. (2014, pp 89-91) also point out how difficult it is to reliably estimate population numbers from habitat assessments and

or dam counts, and highlight this by suggesting that such an approach would estimate anywhere between 312 and 58,680 beaver with a best guess of roughly 12,887 dam-building beaver. By contrast, estimating the capacity of streams to support dam building (i.e. how many dams per mile could fit), has been shown to be a reliable method of estimating where beaver build dams and developing realistic expectations for upper limits on such activity (Macfarlane et al., 2015). Such an example is shown in Figure 2 for the entire state of Utah and suggests that at least 226,939 beaver dams could be supported in the state under current conditions. Current beaver distribution and abundance is not fully understood, however they are considered common and occupy much of their historic range. However, based on scaling of partial dam counts (n = 2852 dams over 2128 miles) by Macfarlane et al. (2014) capacity estimates suggests there are likely somewhere between 20,000 and 40,000 beaver dams currently in the state of Utah. The suggestion is that there is significant additional capacity in the system to support more beaver dams, as well as more beaver.

UTAH GAP ANALYSIS - PREDICTED HABITAT
American Beaver

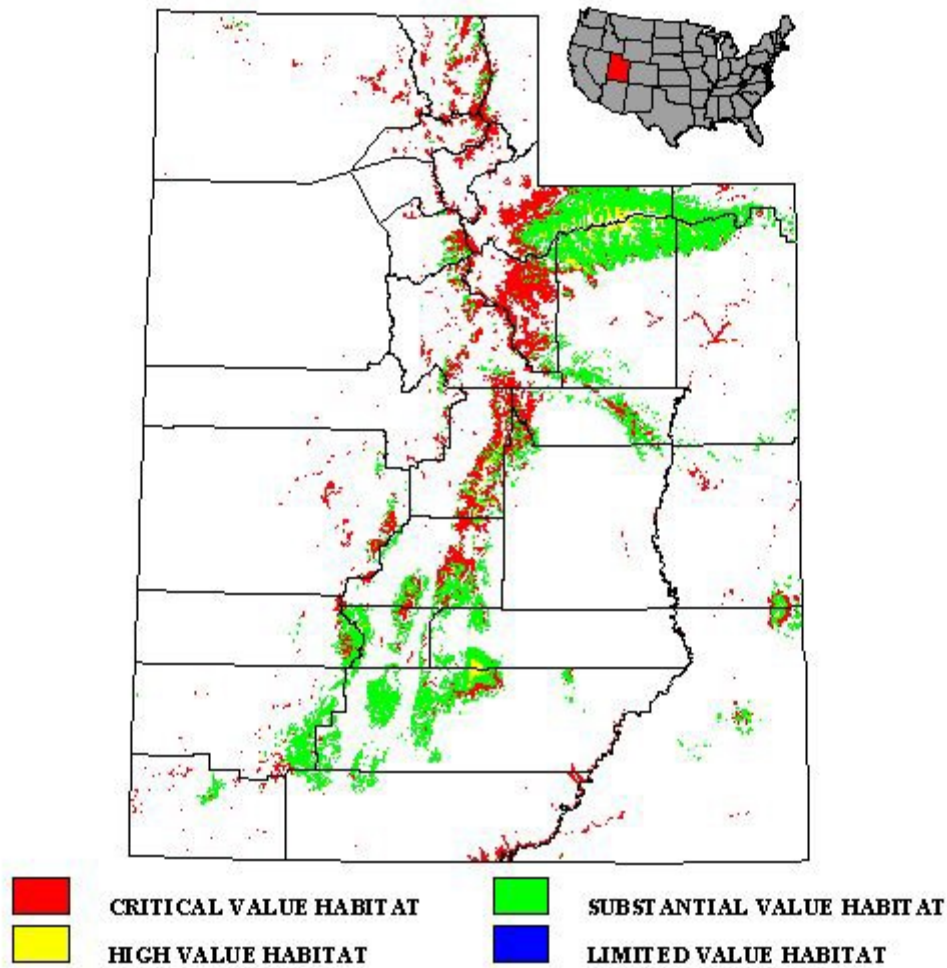|	CRITICAL VALUE HABITAT		SUBSTANTIAL VALUE HABITAT
	HIGH VALUE HABITAT		LIMITED VALUE HABITAT

Figure 1. Predicted beaver 'habitat' from Utah GAP Analysis. This analysis does not differentiate beaver habitat (i.e. anywhere with water and wood) from areas where they build dams. Dams are of interest from a management perspective both for the nuisance damage they can cause (flooding and clogging), as well as the ecosystem services they provide in other areas.
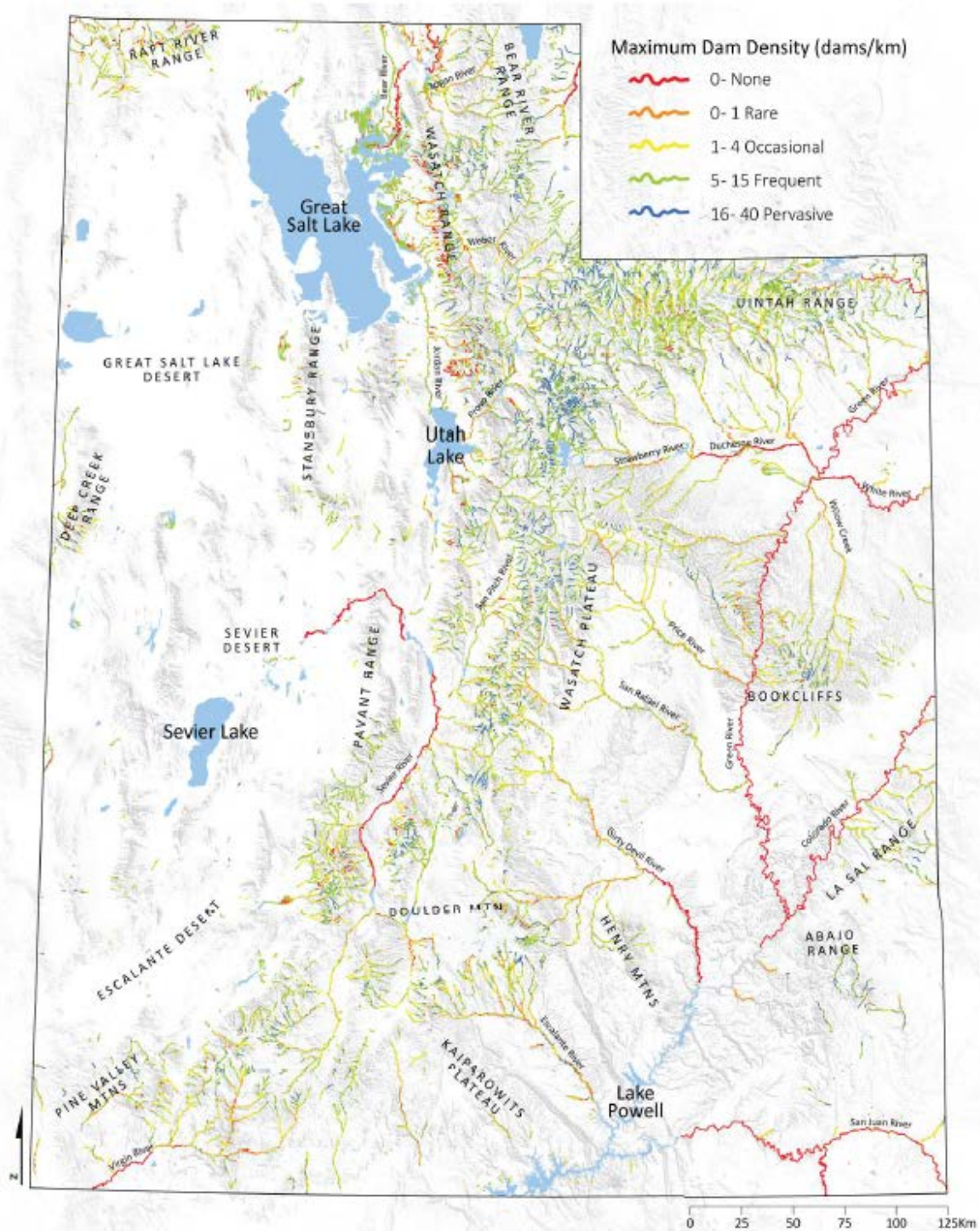
Figure 2. A beaver dam capacity estimate based on existing vegetation and hydrologic conditions. This type of model predicts the 'capacity' of individual stream reaches to support dam building activity (maximum number of dams per mile of stream). This estimate from a UDWR study by Macfarlane et al. (2014), conservatively suggests even with current somewhat degraded stream conditions, Utah's 16,990 miles (27,344 kilometers) of perennial streams could support up to 226,000 beaver dams.

Legal Status

Beaver in Utah are classified as protected wildlife. The UDWR is responsible for their management. There is an open trapping season, which generally runs from October through early April with unlimited take. Beaver causing damage may be taken or removed by the public during closed seasons provided a permit is obtained from UDWR. The UDWR also licenses nuisance wildlife control companies to lethally remove beaver causing damage at any time of year.

Management Actions

The state legislature made it illegal to "kill" beaver in 1899. In 1915 the UDWR (formally referred to at the time as the Utah Fish and Game Department) was given authority to live trap and transplant nuisance beaver. Many of these animals were moved around the state and this effort continued at least through 1954. Live trapping efforts as far as number of individuals, source and translocation sites were not well documented.

Harvest by commissioned trappers began in 1922. From 1922 to 1953 duly commissioned trappers were allowed to harvest beaver with 50% of the pelt proceeds retained by the state. Pelt prices began to drop in 1953, resulting in an upward adjustment of the percentage paid to commissioned trappers. By 1957 the UDWR was given authority to establish an open beaver trapping season eliminating the need for most commissioned trappers other than UDWR employees. During open seasons there was no bag limit but trappers were required to submit their pelts to conservation officers for tagging. Officers tagged each pelt for a fee of $1.00. This fee was reduced to $.50 in 1968. The tagging requirement was discontinued in 1974. A statewide beaver trapping season from October to early April with unlimited take has been in place from 1957 to present. Site specific closures have been periodically used to reduce harvest.

Early beaver management consisted of assessing populations in select streams within defined beaver management units. An annual report has been published with beaver management recommendations and limited harvest statistics since 1953. The management recommendation section of the annual report was dropped in 1981. Sport harvest reporting began in 1958 with harvest statistics collected annually since that time. It was not until 1972 when a metric used to measure trapping effort was collected as part of the annual harvest survey. This metric is expressed as the number of trap set-days/beaver. Since 1983 trap set-days per beaver have ranged from 8 to 55.

Nuisance beaver control activities were tracked from 1958 through 1980 and include UDWR and authorized citizen removals. It is unclear if this data were collected prior to 1958 or after 1980.

Harvest statistics for beaver can be found in the UDWR's annual reports for furbearers on our website.

ASSESSMENT

Issues and Concerns

The initial Beaver Advisory Committee in 2010 identified a list of issues and concerns that should be addressed as part of the planning effort. Many of these issues have been addressed since then and additional issues were identified when the plan was reviewed in 2017. The following list comprises these issues.

Outreach / Education

- Education on
    - non-lethal control methods
    - the habitat values of beavers
    - accommodating beaver working with private neighbors when a private/public reintroduction is desired
    - restoration techniques using beaver
    - expectation management when using beaver as a conservation and restoration tool
- Plan should balance needs of people, habitat and wildlife species
- Educate the public what UDWR's role or responsibility is in dealing with problem beaver (when we aggressively solve the problem, or when we leave it in the public's hands with the proper permit)

Population Management

- Obtain/Maintain a basic picture of distribution/density of beaver in Utah
- Need to understand we will be working in human altered habitat which requires management
- Consider beaver colony distribution and abundance

Harvest Management

- Concerned about trapping closures
- Closures should have time frames for evaluation (# years closed until evaluation)
- Trapping limits after beaver have established in a stream
- Consider unique harvest regulations
- Don't eliminate fur harvest program
- Support public use of beaver as a furbearer
- Little need to protect translocated beaver in areas with poor vehicle access and/or during times with low demand for pelts, as is currently the case

Damage Management / Beaver Conflict Management

- Deal with problems in some areas
    - keeping water moving in small systems
    - wetland management concern
    - lethal vs. nonlethal removal decision model
- Problem beaver management using trappers
- Process to streamline problem beaver management using trappers (COR's for trappers statewide)
- Retain ability to help cooperators in a timely fashion (beaver damage)
- Educate the public about non-lethal techniques
- Refer trappers to resolve problems
- Build statewide list of trappers willing to help solve the problem
- Conflict areas were beavers should not be allowed to establish dams
- Consider management system (decision matrix) from non-lethal to lethal control
- Use of explosives to breach dams with other agencies assisting. Improve communication within UDWR when beaver dams are removed
- Materials list/specifications for flow control devices (pond leveler, culvert protection)
- Video on construction of flow control devices
- Problems in managed wetlands, resolve with non-lethal methods
- Provide drawings of non-lethal management techniques
- Tree protection methods for new restoration sites
- Cooperate with private landowners and water right holders with both removal and introductions
- Procedures for handling nuisance beaver written into a policy similar to other species like cougar and bear
- Refine the nuisance beaver permit process
- Keep an updated list of local trappers in each region (perhaps on the \S drive)
- Educate the public what our role or responsibility is in dealing with problem beaver (when we aggressively solve the problem, or when we leave it in the public's hands with the proper permit)
- Review the UDWR's role for use of explosives in breeching dams (stream alteration permit process, etc.)
- Maintain a database of beaver problems with GPS locations (create a beaver nuisance form for each region to fill out on every call for better records of problem areas and history)
- Dealing with problem beavers in the following areas
    - Residential urban (tree cutting, flooding)
    - City nuisance beavers (culvert damming, flooding, etc.)
    - Landowners (damming irrigation canals)
    - UDOT (major roadway flooding)
    - Other (Railroads, businesses by rivers – tree cutting-aesthetics)
- Retain ability to cooperatively manage/address nuisance issues around campgrounds, roads, dams/spillways, diversions, trails

- Potential funding and information for non-lethal beaver management structures where appropriate.

Disease/Aquatic Nuisance Species Management

- Disease transmission
- Consider invasive species introductions through transplants (mussels)

Research

- Ability to assist with scientific collection requests

Watershed Restoration

- Some areas suitable for establishment of beaver
  - need to create/establish standards and guidelines for potential release sites
  - need to individually analyze potential release sites due to existing riparian health mitigation
  - internal scoping (NEPA) process necessary before relocation could occur (BLM land)
- Transplants of native wildlife (beaver) are generally considered "State Actions" and as such, typically require no National Environmental Policy Act documentation unless federal funds are involved.
- Pro beaver transplant
- Support restoration of beaver and adequate protection where establishing
- List of
  - sites approved/available for reintroduction
  - source sites
- Encourage live-trapping of entire families
- List of people who know how to live trap
- Explore certification of non agency people to live trap and move beaver to approved sites
- Develop list of beaver re-introduction sites (private lands) and source populations
- Water right issues
- Go to areas with the least number of conflicts
- Cooperate with private landowners and water right holders with both removal and introductions
- Consider using beaver as a stream restoration tool
- Beaver are a good tool that could be used to restore degraded riparian communities that could benefit many other wildlife species

- Need to consider the site characteristics of the locations where beaver will be relocated/re-introduced
    - Enough vegetation to support a beaver population
    - Will they create more depredation problems in the new location? i.e. roads, private land, water rights, etc.
    - How will they affect the fish habitat/population and migration?
- Potential funding and information for non-lethal beaver management structures where appropriate
- Transplant "stock" should not be held to nuisance beaver only, as has been the case in the past…more efficiency in capture and movement as well as success in survival could be attained by using beaver from colonies in neighboring watersheds
- Little need to protect translocated beaver in areas with poor vehicle access and/or during times with low demand for pelts, as is currently the case
- Potential benefits of aspen/cottonwood restoration in improving beaver habitat

OBJECTIVES, STRATEGIES AND MANAGEMENT SYSTEM

The Beaver Advisory Committee developed the plan goal, objectives, strategies and management system to address identified issues and concerns. Following are the objectives, strategies and management system developed by the advisory committee. The plan goal is found at the beginning of the document on page 4. In 2017 after working on many of the goals spelled out by the committee the plan was revised to implement new tools and research.

Outreach and Education

Objective 1:

Increase awareness of and appreciation for the role of beaver in Utah's ecosystems by stakeholders (landowners, educators, recreationalists, sportsmen, water rights holders).

Strategies:
1. Conduct a baseline survey of stakeholders to establish their current understanding of the role of beaver in Utah's landscape.
2. Establish at least one showcase beaver management area in each UDWR Region.
3. Evaluate program effectiveness periodically or as new information and research becomes available.

Strategies Accomplished as of 2017 Review:

1. Developed "Living with Beaver" informational materials outlining the difference between nuisance and beneficial beavers and options for landowners, agencies and the general public for coexisting with beavers (Tippie, 2010). These materials highlighted techniques, benefits and costs associated with non-lethal

methods for beaver management all the way through lethal removal as a final option. See also http://beaversolutions.com and Pollock et al. (2015).
2. Adaptive beaver management plans have been prepared for Park City, Walmart in the City of Logan (Portugal et al., 2015a), and Hardware Ranch to mitigate beaver nuisance activities, but allow beaver to stay in an area. The plans can be adapted to other situations, but show how problem identification, alternative pathways, and identify triggers and options for mitigation activities.
3. Completed Wildlife Notebook Series publication on beavers.

Objective 2:

Improve the understanding of all UDWR and other governmental agency employees involved in beaver management and assure consistent transmission of information and application of management actions.

Strategies:
1. Conduct a baseline survey of agency employees to establish their current understanding of beaver management options and the role of beaver in Utah's landscape.
2. Assess how the agencies currently handle beaver management challenges.
3. Establish guidelines to bring consistency and inform UDWR employees and assisting agencies (similar to cougar and bear guidelines) by outlining procedures for management of beaver in urban, rural and upper watershed settings.
4. Evaluate program effectiveness periodically or as new information and research becomes available.

Population Management

Objective 1:

Maintain reproducing beaver populations within their current distribution in appropriate habitat. (See Watershed Restoration Objective for population expansion)

Strategies

1. Actively pursue funding and partnerships to conduct ground and possibly aerial beaver population and habitat suitability surveys to obtain 1) detailed distribution information: and, when possible, density estimates.
2. Obtain methodologies and results from other agencies currently conducting beaver surveys. Consider the methodology developed by UDWR in the statewide 1971-1981 study to allow for comparison of current and historical population data.

Harvest Management

Objective 1:

Maintain recreational opportunity for a minimum of 350 trappers and a sustainable harvest of 3,500 beavers annually. (See Watershed Restoration Objective for population expansion)

Management System:

Maintain baseline regulated statewide harvest management program of traditional seasons and unlimited take unless:

1) Average set-days/beaver over a three year period is greater than 34; then season length will first be shortened (open a week later and close a week earlier) and if additional protection is necessary, area closures will be expanded to bring set-days/beaver into historical range (11 to 34 set-days/beaver) over the following three year guidebook cycle.

(-OR-)

2) Average number of beavers trapped over a three year period exceeds 3,500 and average set-days/beaver goes above 18; then season length will first be shortened (open a week later and close a week earlier) and, if additional protection is necessary, area closures will be expanded to reduce harvest and maintain catch per unit effort below 18 set-days/beaver over the following three year guidebook cycle.

Strategies:

1. Continue post season furbearer surveys to estimate beaver harvest, number of trappers and catch per unit effort at the county level.
2. Evaluate the need for stream closures, based on both sustainable harvest targets and restoration objectives, listed in the guidebook once every three years. Remove or add streams based on achieving desired results, harvest vulnerability and high level of conflict. Post signage of temporary harvest closures to notify public both of closure and its intended benefits (e.g. population viability, sustainable harvest, restoration, etc.; (Figure).
3. Determine the level of protection required for translocated or diminished beaver populations by considering harvest vulnerability. Create and maintain a map of known and or monitored beaver populations within UDWR. One of the following approaches will be selected.
   a. (High Harvest Vulnerability i.e. less than 0.5 mile from open roads/access points) – close specific watersheds for a given length of time. Generally the length of time should not exceed six years or two three-year guidebook cycles. Upon transition from the high harvest vulnerability, the population will be provided protection identified under the moderate harvest vulnerability approach.
   b. (Moderate Harvest Vulnerability i.e. 0.5 to 1.0 mile from open roads/access

points) – encourage light harvest by signing appropriate areas to obtain voluntary compliance. This management approach will be useful for streams that fall between the high and low harvest vulnerability.

   c. (Low Harvest Vulnerability i.e. over 1.0 mile from open roads/access points) – access constraints or demand for pelts limit trapping interest. This management approach is self regulating (requires no action) and relies on the "law of diminishing returns".

4. Upon completion of a statewide population survey (contingent upon available funding) identified in Population Objective section of the plan (O1 S3), the current beaver harvest management system will be adjusted accordingly. Particular consideration should be given to use of closures in areas to which beaver are being translocated and/or areas where restoration efforts are focused on getting viable populations. Note that population surveys should not be based on number of dams, dam complexes or lodges alone, as individual beaver colonies in Utah have been shown to actively maintain numerous complexes and lodges over 10's of kilometers of streams (i.e. easy to over-estimate population from dam counts).

Figure 3– Example of signage used to notify public of temporary beaver harvest closure and its intended purpose.

Strategies

1. Harvest closures were implemented on a number of streams in the state (e.g. Figure) to 1) encourage recovery and expansion of existing populations in particular streams for habitat restoration purposes; 2) to provide protection for translocated beaver to new systems where their populations had not established; and 3) facilitate research and monitoring of beaver activity and impacts in study systems without confounding factors of harvest.

Damage Management

Objective 1:

Increase consistency in the response options (lethal and non-lethal) currently in use and increase the frequency of use of non-traditional options (e.g. beaver deceivers, live-trapping) used by UDWR, governmental and non-governmental agencies and landowners for managing beaver causing property damage.

Strategies:

1. Assemble a list of available control/abatement options currently in use in Utah by UDWR, governmental and non-governmental agencies and landowners.
2. Implement non-lethal, living with beaver mitigation options to mitigate nuisance behavior and damage from beaver where possible (e.g. see Figure 4). Encourage following a process of specific evaluation of threats and or damages potential nuisance beaver could or are actually cuasing, and proceed through a series of management responses that start simple and inexpensive, and progress as needed through more involved responses (see Figure 4 for example considerations within water courses and Figure 5 on a beaver dam by dam basis).
3. Continue to issue Certificates of Registration (COR) to nuisance wildlife companies. Look for opportunities to relax control options available to companies (e.g. live trapping, snares and other methods).
4. Generate and maintain a list of individuals that have an interest in trapping beaver (including live-trapping).
5. Issue CORs to live-trappers who have undergone training, issue letters of authorization to lethal trappers on the list to address problems outside the trapping season and use them as a resource to help resolve nuisance conflicts where 'living with beaver' mitigation strategies are either not an option or not successful
6. Maintain a list of seasoned trappers by county of interest to harvest beavers as an option to resolve issues in high conflict areas during the trapping season. This list will be retained, updated and distributed by UDWR.
7. Use outreach materials described in Outreach and Education section of this plan (O1 S3) to inform landowners of the options available to address present and prevent future damage caused by beaver. Develop webpage on UDWR website as resource for land owners.
8. As agency personnel work through options for addressing present and preventing future damage caused by beaver, use the guideline (tiered approach) proposed in the Outreach and Education section of this plan (O2 S3). Where appropriate, use adaptive beaver management plans to address and map concerns.
9. Develop an online nuisance beaver reporting form and central database to track damage complaints (inter- and intra-agency), for the purpose of documenting *actual realized* high conflict areas, differentiating those from BRAT-predicted *potential* conflict areas (http://brat.joewheaton.org), and to tracking costs and effectiveness of methods. If possible, revise BRAT conflict models (Figure 6) to reflect nuisance reports as well as management, stakeholder and landowner tolerances for beaver conflicts and willingness to mitigate by non-lethal means.

10. Where dam removal is deemed necessary, and explosives are used as a means of dam removal, each DWR region will evaluate need and provide certified explosives training to employees who will use this method of dam removal. Coordinate beaver dam removal efforts within and among agencies to insure non-target species are not affected.
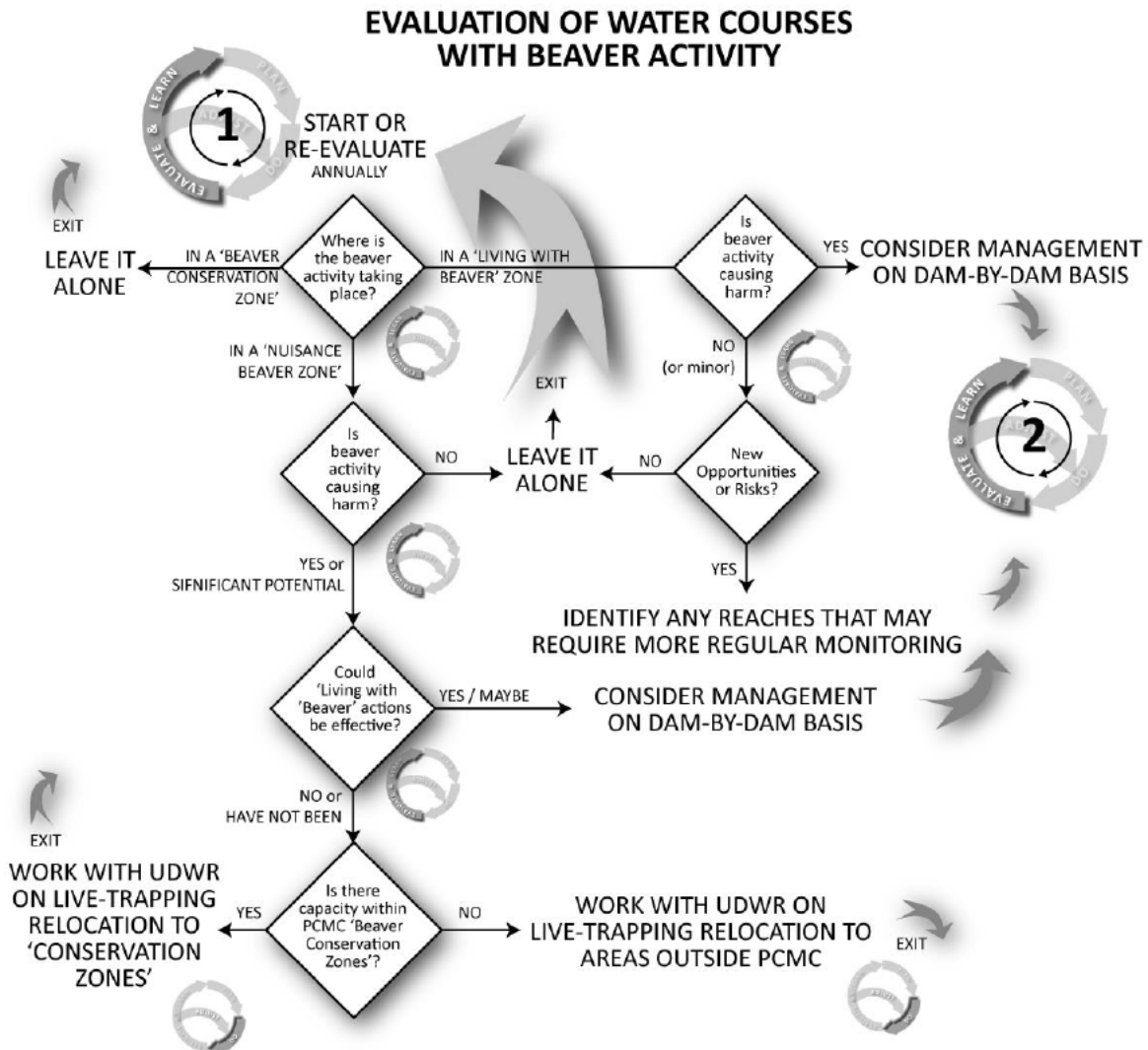11. Develop an MOU between UDWR and USDA Wildlife Services for nuisance beaver management and response.

Figure 4 – Example of evaluation of beaver activity in water courses for damage management. This represents a key component of an 'adaptive beaver management' plan for evaluating potential 'nuisance beaver activity' on water courses mapped as 'Living with Beaver' zones in BRAT Management model. Figure from Wheaton (2013) developed for Park City Municipal Corporation (PCMC), but could be adapted as needed.

EVALUATION OF INDIVIDUAL POTENTIAL PROBLEM DAMS

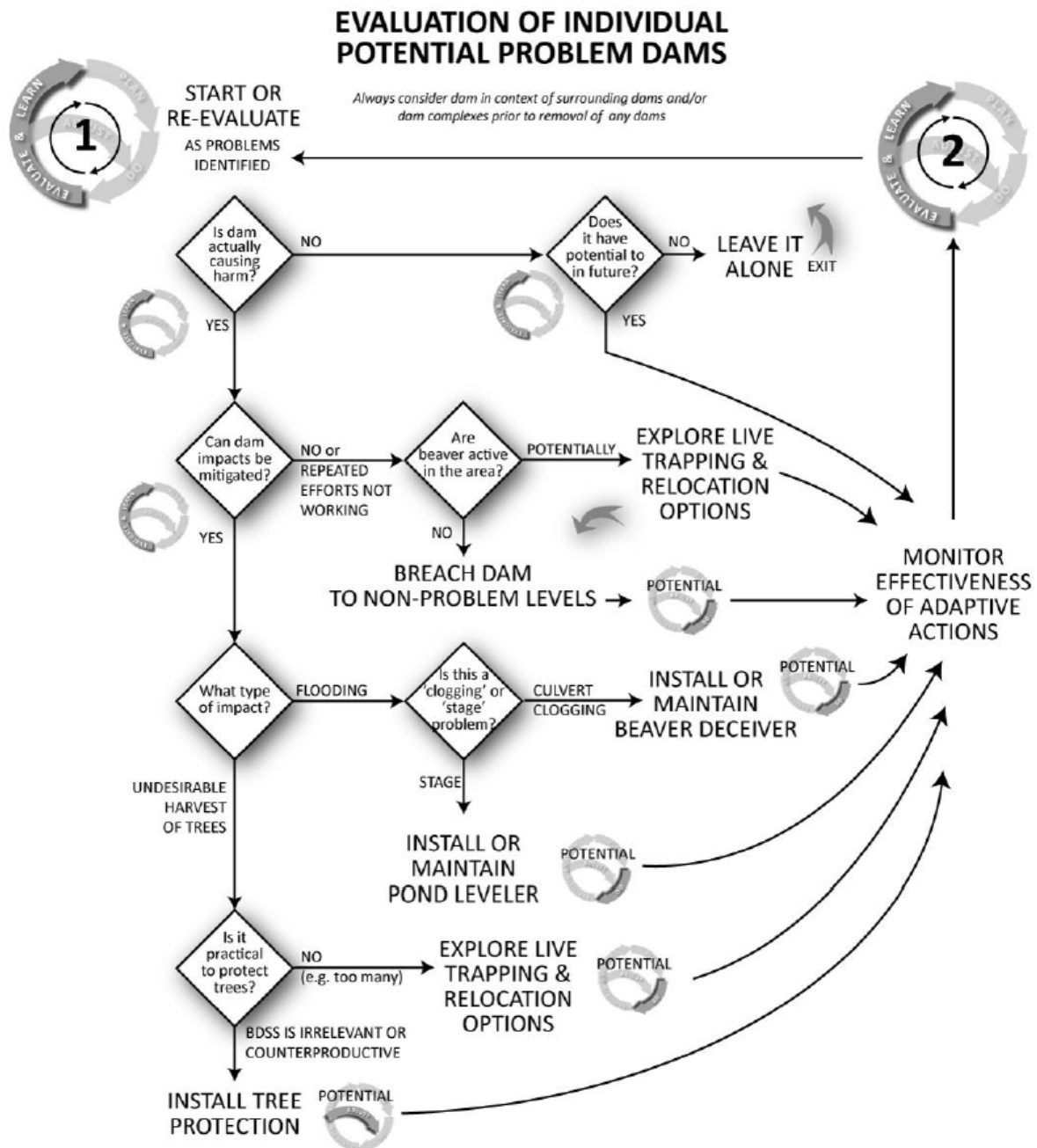*Always consider dam in context of surrounding dams and/or dam complexes prior to removal of any dams*

Figure 5 - Example of considerations of individual potential problem beaver dams and management responses. This is a key component of an 'adaptive beaver management' plan for evaluating potential 'nuisance beaver activity' at individual dams in water courses mapped as 'Living with Beaver' zones. Figure from Wheaton (2013) developed for Park City Municipal Corporation (PCMC), but could be adapted for UDWR purposes.
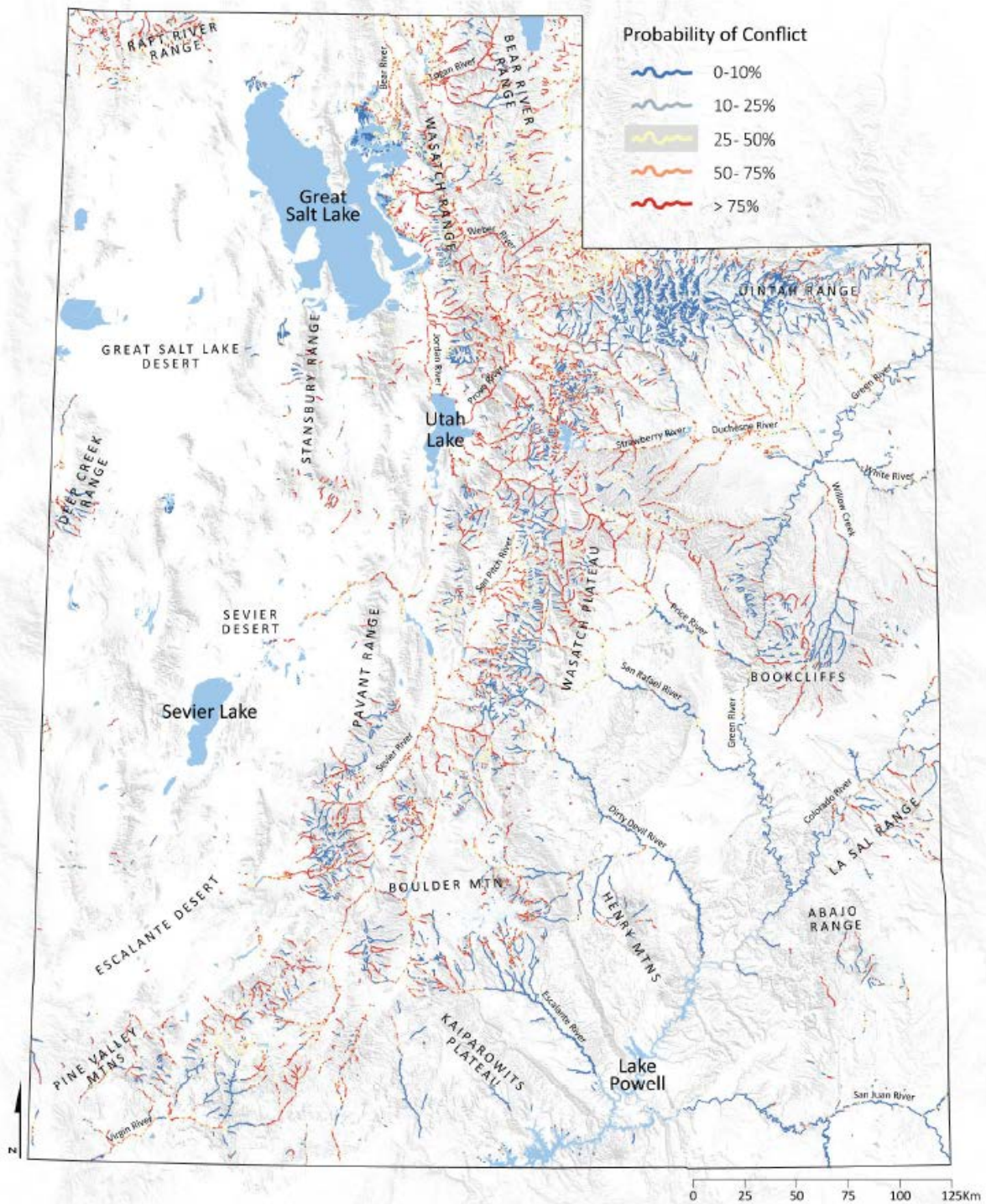
Figure 6 – Example of a human-beaver potential conflict model, based on proximity to roads, culverts, bridges, railroads and more intensive land uses from Macfarlane et al. (2014).

Strategies Accomplished as of 2017 Review

1. Since 2010, a variety of non-lethal control/abatement and living with beaver options have been successfully employed throughout the state ranging from beaver deceivers, pond-levelers and caging, to live-trapping and relocation. These solutions

are not fool-proof, but are cost effective and have been working.

2. Training of 'living with beaver' mitigation strategies has been provided to UDWR, NRCS, BLM and USFS partners within Utah (http://beaver.joewheaton.org), and these agencies have all successfully enacted such mitigation strategies on a mix of private and public lands within Utah.

3. Adaptive beaver management plans have been prepared for Park City (Wheaton, 2013), Wal-Mart in the City of Logan (Portugal et al., 2015a), and Hardware Ranch (Portugal et al., 2015b) to mitigate beaver nuisance activities, and progress through a series of simple and cost effective alternatives. The plans can be adapted to other situations, but show how problem identification, alternative pathways, and identify triggers and options for mitigation activities.

4. The Utah BRAT model (Macfarlane et al., 2014) was run state-wide to conservatively identify potential human-beaver potential conflict areas (likely an over-prediction) and combines this with context of dam-building capacity models to identify 'Living with Beaver' zones. Such zones are predicted to have both the capacity to support dam building beaver, and the potential for that to cause flooding, clogging, or undesirable harvest impacts.

Disease/Aquatic Nuisance Species Management

Objective 1:

Minimize the possibility of spreading aquatic diseases (e.g., whirling disease) and aquatic invasive species (AIS) (e.g., Quagga and zebra mussels, New Zealand mud snails and clams) from known contaminated sources to clean watersheds as a result of moving beaver between drainages through 2020.

Strategies:
1. Use 'The Protocol for Live Trapping, Holding and Transplanting Beaver' to screen source populations of beaver for transfer to other waters. Beavers should not be translocated from known waters containing whirling disease or ANS to waters believed to be clean without first following the Decontamination Protocol.

Strategies Accomplished as of 2017 Review

1. A "Protocol for Live Trapping, Holding and Transplanting Beaver" was developed and followed during live trapping and translocation activities throughout the state. The protocol was updated to make it more pragmatic to implement in 2017.

Objective 2:

Minimize the possibility of spreading aquatic diseases and AIS from known contaminated sources to clean watersheds as a result of lethal trapping used during control actions or recreational seasons.

Strategies:
1. Follow best practices for decontaminating all gear used in translocating beaver.
2. Provide decontamination information via web or brochure to recreational trappers during the purchase of their furbearer license to encourage voluntary compliance with decontamination protocol.

Strategies Accomplished as of 2017 Review
1. Developed a gear decontamination protocol. This included verbiage requiring adherence to decontamination protocol in all COR issued to nuisance wildlife companies.

Research

Objective 1:

Fund applied research that can help improve UDWR's beaver management.

Strategies:
1. Evaluate proposals to UDWR's Research Council and provide support for beaver research.
2. Incorporate the collection of scientific information relative to beavers into the MOU with USDA Wildlife Services.
3. Encourage and support research proposals aimed at better assessing and tracking beaver population dynamics.
4. Encourage and support research to improve the understanding of the benefits and impacts of beaver dam building activity on other UDWR target management species as well as ecosystem services provided by beaver dams.
5. Consider partnering with UDWR staff, WRI, Utah AGRC and USU to improve and update BRAT with more resolved management layers and inputs. These include: censusing beaver dams throughout the state, tracking beaver dam dynamics, inventorying beaver nuisance issues, mapping land owner and management tolerances for beaver, and exploring water resources impacts.

Strategies Accomplished as of 2017 Review:

1. A $40,000 UDWR grant to Utah State University was used to fund the development and application of the Beaver Restoration Assessment Tool (BRAT – http://brat.joewheaton.org), which has been used to set more realistic expectations for where various management strategies involving beaver make most sense (Macfarlane et al., 2015; Macfarlane et al., 2014; Wheaton and MacFarlane, 2014).
2. With support from USFS, research from Lokteff et al. (2013) assessed the degree to which beaver dams impact the movement of trout in Temple Fork (Northern Region).
3. With support from the USFS, Hafen (2017) evaluated the how much surface water storage and increase in groundwater storage was possible with beaver dams throughout the entire Bear River Basin and specifically addressed 'to what extent might beaver dam building buffer water storage losses associated with a declining snowpack?'

Watershed Restoration

Objective 1:
Work to improve riparian habitats, associated streams and wetlands in as many suitable tributaries as is feasible through translocating beaver into unoccupied suitable habitat on public and/or private land.

Strategies:
1. Facilitate and promote beaver-assisted restoration activities with translocation of nuisance beaver in ways that minimize potential for human-beaver conflicts as a result of the translocation, and maximize likelihood that beaver will take to a particular area. As a first pass at making this assessment and in preparing planning materials or funding applications, leverage the Utah Beaver Restoration Assessment Tool (BRAT) from Macfarlane et al. (2015); Macfarlane et al. (2014) to evaluate potential transplant sites. Sites that qualify as "Low-hanging Fruit Restoration Zone" (i.e. have ample existing capacity and minimal conflict potential), and/or sites that are identified as "Quick Return Restoration Zone" should be considered for transplants first (e.g. Figure 7). By contrast, site mapped as 'Long Term Restoration Zone' may require improvements to riparian and or grazing management first, before being suitable release sites for beaver. Utah BRAT by Macfarlane et al. (2014) was produced with nationally available datasets and should not be treated as the 'absolute answer', nor does it provide coverage of some areas (e.g. streams mapped as intermitent, but that are actually perrenial) that may be suitable release sites. Sites that do not fall into these categories can be evaluated on a case by case basis, but priority will be given to sites identified by BRAT and verified in the field and fall in these categories.
2. Conduct site-specific evaluations using BRAT and considerations posed by Woodruff and Pollock (2015). Coordinate within DWR sections to evaluate suitability of reintroduction sites.
3. Coordinate at the UDWR regional level with land management agencies to

determine the level and need for environmental compliance (NEPA).

4. UDWR regional personnel will coordinate with local governments, land management agencies, private landowners and any other affected parties that have an interest (positive or negative) in the establishment of beaver populations within translocation watershed.

5. Develop at the UDWR regional level Habitat Authorization, Watershed Initiative project proposals, and other possible sources to fund site-specific beaver translocations for the purpose of restoring important statewide aquatic environments.

6. When possible, live trap and translocate entire family groups. If not possible, find suitable male-female adult pairs for release together.

7. Generate a list of trained UDWR personnel that have an interest in live trapping beaver and use them as a resource to establish new populations. Issue CORs to trained non-UDWR personnel for the purpose of assisting with live-trapping and translocation efforts. A base requirement for a COR would be the applicant's ability to demonstrate proficiency in live trapping and translocation.
   1. Proficiency would be demonstrated by successful completion of a
   2. UDWR-approved training program.
   3. Incorporate live-trapping options into the MOU with USDA Wildlife Services.

8. Encourage land management agencies and private property owners to manage riparian habitat (aspen, willow and cottonwood) to support translocated beaver populations. Work with Utah Grazing Improvement Program and ranchers on both private and public land to find management solutions that promote the co-existence of sustainable grazing with thriving beaver populations.

9. Select a level of harvest protection for translocated beaver populations from the Harvest Management Objective section (O1 S3abc).

10. If there is likelihood that translocated beaver could become a nuisance within 5 miles of a release site and stakeholders are concerned, an adaptive beaver management plan should be developed to identify how they will be dealt with utilizing strategies identified in the Damage Management section.
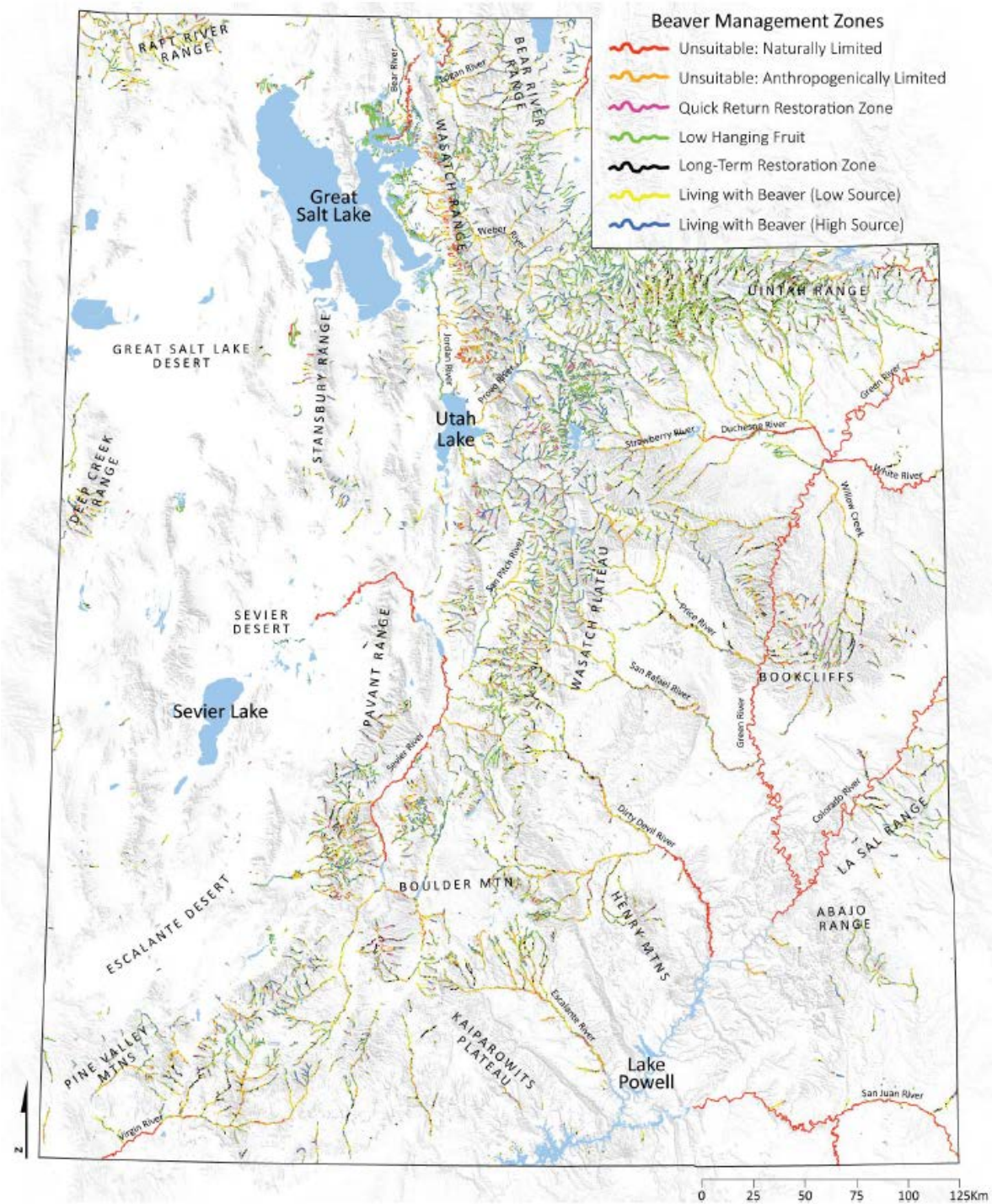
Figure 7 – Example from BRAT (Beaver Restoration Assessment Tool) of preliminary, model predicted potential beaver management zones.

Strategies Accomplished as of 2017 Review

1. Nuisance beaver had been successfully translocated to a variety of watersheds throughout the state and used as a restoration agent.

Objective 2:
Facilitate and promote beaver-assisted restoration activities and expansion of existing beaver populations in areas that beaver are already present, habitat exists to already support them and human-beaver conflict potential is low and/or easily mitigated.

Strategies:
1. Identify areas with beaver activity, where there dam footprint could be expanded without causing impacts. This can be done using a mix of existing beaver dam surveys, beaver activity surveys, and leveraging BRAT capacity model assessments. Where existing number of dams in potential 'restoration or conservation zones' is well below BRAT predicted capacity (i.e. < 10% of capacity), promoting expansion in these areas is recommended.
2. Assess what might be limiting or keeping beaver from expanding (e.g. limited woody vegetation resources, over-trapping, predation, incised channel conditions), and identify management actions that might address those specific limiting factors (e.g. riparian improvement, grazing management changes, temporary tapping closures, more cover (i.e. deep water) for beaver, or use of beaver dam analogues to either create some initial cover or intermediate stability from flood disturbance).

LITERATURE CITED

Baker, B.W., Hill, E.P., 2003. Beaver (*Castor Canadensis*). In: G.A. Feldhamer, B.C. Thompson, J.A. Chapman (Eds.), Wild Mammals of North America: Biology, Mangement and Conservation. The Johns Hopkins University Press, Baltimore, Maryland, pp. 288-310.

Blackwell, B.H., Pederson, J.C., 1993. Beaver distribution, habitat and population survey, Utah Division of Wildlife Resources, Salt Lake City, UT.

Durrant, S.D., 1952. Mammals of Utah, taxonomy and distribution. University of Kansas Publications Museum of Natural History 6, 1-1549.

Dyck, A.P., Macarthur, R.A., 1993. Daily Energy-Requirements of Beaver (Castor-Canadensis) in a Simulated Winter Microhabitat. Can J Zool, 71(10), 2131-2135.

Hafen, K., 2017. To what extent might beaver dam building buffer water storage losses associated with a declining snowpack? MS, Utah State University, Logan, UT, 123 pp.

Jenkins, S.H., 1981. Problems, progress, and prospects in studies of food selection by beavers. In: J.A. Chapman, D. Pursley (Eds.), Worldwide Furbearer Conf. Proc., Vol I., pp. 559-579.

Lokteff, R.L., Roper, B.B., Wheaton, J.M., 2013. Do Beaver Dams Impede the Movement of Trout? Trans. Am. Fish. Soc., 142, 1114-1125.

Macfarlane, W.W., Wheaton, J.M., Bouwes, N., Jensen, M.L., Gilbert, J.T., Hough-Snee, N., Shivik, J.A., 2015. Modeling the capacity of riverscapes to support beaver dams. Geomorphology.

Macfarlane, W.W., Wheaton, J.M., Jensen, M., 2014. The Utah Beaver Restoration Assessment Tool: A Decision Support & Planning Tool, Ecogeomorphology and Topographic Analysis Lab, Utah State University, Prepared for Utah Division of Wildlife Resources, Logan, UT.

Pollock, M.M., Lewallen, G., Woodruff, K., Jordan, C.E., Castro, J.M. (Eds.), 2015. The Beaver Restoration Guidebook: Working with Beaver to Restore Streams, Wetlands, and Floodplains. Version 1.0. United States Fish and Wildlife Service.

Portugal, E., Wheaton, J., Bouwes, N., 2015a. Spring Creek Wetland Area Adaptive Beaver Management Plan, Prepared for Walmart Stores Inc. and the City of Logan, Logan, UT.

Portugal, E., Wheaton, J., Sorenson, K., Majerova, M., Hunt, B., Bouwes, N., 2015b. Hardware Ranch Adaptive Beaver Management Plan, Prepared for Utah Division of Wildlife Resources, Logan, UT.

Rawley, E.V., 1985. Early records of wildlife in Utah, Utah Division of Wildlife Resources Salt Lake City, UT.

Tippie, S., 2010. Working With Beaver for Better Habitat Naturally!, Wildlife 2000 & The Grand Canyon Trust, Flagstaff, AZ.

Wheatley, M., 1997a. Beaver, Castor canadensis, home range size and patterns of use in the taiga of southeastern Manitoba .1. Seasonal variation. Canadian Field-Naturalist, 111(2), 204-210.

Wheatley, M., 1997b. Beaver, Castor canadensis, home range size and patterns of use in the taiga of southeastern Manitoba .2. Sex, age, and family status. Canadian Field-

Naturalist, 111(2), 211-216.

Wheatley, M., 1997c. Beaver, Castor canadensis, home range size and patterns of use in the taiga of southeastern Manitoba .3. Habitat variation. Canadian Field-Naturalist, 111(2), 217-222.

Wheaton, J., 2013. Scoping Study and Recommendations for an Adaptive Beaver Management Plan. , Prepared for Park City Municipal Corporation, Logan, Utah.

Wheaton, J.M., MacFarlane, W.W., 2014. The Utah Beaver Restoration Assessment Tool: A Decision Support & Planning Tool – Manager Brief, Ecogeomorphology and Topographic Analysis Lab, Utah State University, Prepared for Utah Division of Wildlife Resources, Logan, UT.

Woodruff, K., Pollock, M.M., 2015. Relocating Beaver. In: M.M. Pollock, G. Lewallen, K. Woodruff, C.E. Jordan, J.M. Castro (Eds.), The Beaver Restoration Guidebook: Working with Beaver to Restore Streams, Wetlands, and Floodplains. Version 1.0. United States Fish and Wildlife Service, Portland, OR, pp. 61-81.