

## Strawberry Reservoir Fishery Management Plan

05/02/2022

The following management plan drafted for Strawberry Reservoir was developed by the Utah Division of Wildlife Resources with input from the Strawberry Management Plan Advisory Team. The plan development process was facilitated by Jason Vernon (UDWR) and discussions and presentations led by Alan Ward (Strawberry Project Leader UDWR), and minutes were taken by Weston Pearce (Strawberry Project Biologist UDWR). The following entities and individuals were represented on the advisory team:

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*Dave Lupold*
- Wasatch County  
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- Strawberry Water Users  
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*Ron Dunn, John "Andy" Clark*
- Sportsmen for Fish and Wildlife  
*Ken Strong*
- Blue Ribbon Fisheries Advisory Council  
*Randy Oplinger*
- Utah Recreation Company  
*Nick Smith*
- Friends of Strawberry Valley  
*John Schultz*

Data from UDWR angler opinion surveys conducted during 2020, and the biological data obtained from the Strawberry Reservoir Special Project Office of the UDWR were also used to help guide the discussion and provide a basis to build the plan upon. Due to the high profile nature of Strawberry Reservoir, it was imperative that considerable public input from the opinion surveys, and the input from a very diverse advisory team, be allowed to drive the ultimate direction that this plan would take. The previous plan, developed in 2014, was in need of being updated with the most current biological data and public opinions. The 1987 plan was successful in building one of the most important sport fisheries in the Western United States, which receives as much as 1.5 million angler hours annually, and the 2014 plan helped to bring things more up-to-date. In 2006, the Strawberry Project received a distinguished award as the "Outstanding Project of the Year" in North America by the National American Fisheries Society, further validating the success of the program at Strawberry Reservoir. The following plan serves as the guiding document to help managers maintain, and even improve, this important world class fishery into the foreseeable future.

The following Strawberry management plan is comprised of two major components: Goals and Objectives. The "Goals" are the basic concepts that the group decided upon as overriding visions of what is desired from the fishery at Strawberry Reservoir. The "Objectives" outline more specific (often measurable) outputs that need to be met to provide the desired components to the fishery. In addition, a "Discussion and Strategies" section provides more detail and background validating the reasoning for each Goal and Objective, and the "Strategies" are a list

of possible tools or methods to obtain the related objective. It is important to note that the listed strategies are not a comprehensive list, nor do they provide a checklist, or stepwise approach, to meeting the objectives. They are simply a list of potential tools that should be considered in meeting the Goals and Objectives.

Though not identified as a goal or objective in the plan, it is important to note that illegal introductions of aquatic species are serious problems facing most fisheries. Illegal introductions have occurred, or have been attempted, at Strawberry in the past (Utah chub, smallmouth bass, and others). Fish species illegally introduced into Strawberry Reservoir will not be managed for or promoted, and appropriate actions will be taken on a case by case basis.

It should also be emphasized up front that the stocking of hatchery reared fish is vital to the success of the management plan at Strawberry Reservoir. And though the plan does continue to emphasize the importance of maintaining, and increasing, natural recruitment in the system, stocking will continue to be vital to overall success due to the high level of angling pressure that Strawberry Reservoir receives annually. It also must be acknowledged that there are obvious limitations on the State's fish production capabilities, and it will not always be possible to increase fish production within our current hatchery system to offset unforeseeable shortfalls in meeting some of the objectives set in the plan. Therefore, working within the constraints of our production capabilities and fish needs at other waters state-wide will need to be considered.

## **Strawberry Reservoir Management Plan**

### **Guiding Statement**

*“Protect and enhance the unique, year-round angling experience that Strawberry Reservoir provides as one of Utah’s premier cold water fisheries”*

### **Goals**

#### **1. Prevent Utah chubs from negatively impacting the sport fishery at Strawberry Reservoir**

##### Objectives

1. Maintain minimum condition factor [ $k_{TL} = \text{Weight gm}/(\text{TL mm})^3 \cdot 10^5$ ] of 0.82 in age 2 cutthroat during the fall netting.
2. Limit total catch rate of chubs sampled in gillnet surveys to 1.4/net-hour in overall zone adjusted fall curtain net catch rate<sup>1</sup>.
3. Maintain number of 18” or greater cutthroat trout sampled in gill net surveys between 0.19 and 0.23 /net-hour in overall zone adjusted fall curtain net catch rate<sup>1</sup>.

#### **2. Provide a sport fishery where the species assemblage, fish size, and catch rates will appeal to its anglers**

##### Objectives

1. Maintain an average angler catch rate for rainbow trout between 0.18 and 0.25 fish per angling hour in year-long creel surveys<sup>3</sup> (or a comparable surrogate)

2. Maintain an average summer angler catch rate of 0.125 fish per angling hour for Kokanee salmon as measured in summer (typically July) creel surveys<sup>3</sup>, with a focus on improving and stabilizing kokanee numbers in Strawberry Reservoir.
3. Maintain average size of rainbows in the creel at 15” as measured in year-long creel surveys<sup>3</sup> (or a comparable surrogate), while maintaining opportunities for harvest once the size objective is met.

### **3. Ensure a variety of fishing experiences**

#### Objectives

1. Maintain a minimum fishing pressure of 1 million angler-hours annually, using a minimum of 200,000 angler hours during annual July creel surveys as an indicator of success between full-year surveys<sup>3</sup>. Falling below these levels for more than two consecutive years triggers further surveys and other actions.
2. Maintain a minimum of 150,000 ice angler-hours per year as measured in creel surveys when ice and snow conditions allow<sup>3</sup>. Alternate representative methods should be employed on year’s in-between year-long creel surveys.
3. Take action to provide additional fishing opportunities on Strawberry tributaries.
4. Enhance non-angling fishery related opportunities (viewing events, educational opportunities, and outreach) with angler recruitment focus.
5. Ensure and enhance opportunities for all angler types and methods legally allowed at Strawberry Reservoir.

### **4. Improve natural reproduction of cutthroat trout and Kokanee salmon populations**

#### Objectives

1. Maintain average annual recruitment of Age I cutthroat trout at 0.033 fish per net hour, with a focus on increasing this level.
2. Maintain an average of 0.15 Kokanee per net hour from natural reproduction, with a focus on increasing this level.

*\*A review of this plan (informal and/or formal) should be conducted at least every five years, and formal reviews should coincide with year-long creel surveys and related angler opinion surveys.*

## Discussion and Strategies

**Goal #1 - Prevent Utah chubs from negatively impacting the sport fishery at Strawberry Reservoir** - *Illegally introduced Utah chubs have had negative impacts on the fishery at Strawberry Reservoir during the past. Strawberry has been chemically treated on two occasions in the past (1961 and 1990) in attempts to remove these unwanted introduced species. It is critical to the overall health of the sport fishery that we control the Utah chub populations to try to avoid future problems including the need for expensive and difficult chemical treatments. Proper management of the predatory Bear Lake cutthroat has provided sustainable top down control of the Utah chub populations since 2003, thereby providing a template for control into the future.*

### Objectives

1. Maintain minimum condition factor [ $k_{TL} = \text{Weight gm}/(\text{TL mm})^3 \cdot 10^5$ ] of 0.82 in age 2 cutthroat during the fall netting<sup>1</sup> – *Condition factors [ $k_{TL} = \text{Weight gm}/(\text{TL mm})^3 \cdot 10^5$ ] of age II cutthroat have averaged roughly 0.86 since the 1990 treatment. It is critical to maintain good growth rates and associated condition factors during the first year (for fish stocked as age 1) for the cutthroat to ensure sufficient survival and recruitment to adult sizes for chub control. Reduced growth rates could indicate food limitations brought on through competition for limiting resources. Competition for food resources between trout species and Utah chub led to the previous two rotenone treatments of Strawberry Reservoir.*

### Strategies

- a. Monitor zooplankton for composition, abundance, and size – *Zooplankton comprise roughly 85% and 60% of the age 1 and age 2 cutthroat diets respectively throughout the year. Therefore, tracking zooplankton monitoring is a good way to track food availability for these fish. Current zooplankton sampling includes tows taken during the second week of February, third week of May, first week of August, and the second week of October. The May and October sampling dates coincide with the spring and fall stocking to assess what is available during these periods for stocked fish, and compare it to what is seen in fish diets from gillnetting. Data collected will be used to assess whether significant changes in zooplankton abundance and/or size could be affecting growth and survival of cutthroat trout. Due to the highly variable nature of zooplankton densities, trends over two to three years should be used to signify changes. If a decline is suspected, more intense sampling should be initiated to better document it.*
- b. Monitor water quality annually to assess limitations in growth and survival for cutthroat – *Basic water quality parameters such as temperature, dissolved oxygen, and pH will be monitored by UDWR in the water column in conjunction with zooplankton sampling to assess conditions and potential limitations to survival and growth for the cutthroat and other fish. Receiving water will also be monitored during stocking events to ensure that stocked fish are being placed into favorable conditions. High temperatures (>20 deg C) and low summer oxygen levels below the thermocline occur annually, and reservoir stocking should be avoided during these periods. Stream stocking should again be avoided when daytime temperatures could reach or exceed 20 deg C.*

- c. Monitor interaction of cutthroat trout with other species – *It is imperative that other fish species either currently found in Strawberry, or to be introduced, do not adversely affect the cutthroat trout populations which have proven an effective biological control on Utah chubs in Strawberry Reservoir. Any potential predatory and/or competitive interactions with other game fish should be closely monitored and adjusted to ensure adequate growth and survival in the cutthroat populations to provide the needed chub control. This monitoring will include, but not be limited to, annual curtain netting, hydroacoustic surveys, and fish trap/spawning monitoring operations.*
2. Limit total catch rate of chubs sampled in gillnet surveys to 1.4/net-hour in overall zone adjusted fall curtain net catch rate<sup>1</sup> – *Utah chub numbers have remained relatively low and stable since the enactment of the slot limit on cutthroat in 2003. This catch rate reflects the threshold based on our current curtain netting monitoring operations. The ability to keep Utah chub numbers below this level will help ensure that a quality sport fishery can be sustained into the future without the need for expensive (politically, feasibly, and monetarily) chemical treatments. The last 18 years of data from Strawberry Reservoir suggests that due to Utah chub longevity, and the fact that they can escape cutthroat predation by obtaining large enough sizes to not be eaten for the majority of their life span, there is little hope that chubs will ever be eradicated from the system. However, continued monitoring should also focus on ensuring that any severe reductions in Utah chub numbers do not somehow significantly affect cutthroat growth and condition. With the recent conversion to curtain nets (since 2017) it will also be important to periodically correlate these curtain net catch rates with the traditional net catch rates to make sure that the trends are consistent with the traditional net catch rates over the past 75 years.*

#### Strategies

- a. Adjust cutthroat trout population and age structure to control chubs – *Since 2003 it has been shown that the Bear Lake cutthroat have been extremely effective at controlling Utah chub populations in Strawberry Reservoir. However, adjustments in the management of the cutthroat have been necessary to provide the needed population structure to obtain chub control. In 2003, special regulations (a slot limit eliminating harvest from 15” to 22”) controlling the harvest of cutthroat were placed on the reservoir and have provided more, and larger sized, cutthroat needed to effectively control the chub populations (see Goal 1, Objective 3). Adjustments to numbers, size, and timing of stocked fish have also been necessary to provide the cutthroat numbers and age/size structure needed to control chubs. If chub populations expand beyond the objective with current cutthroat trout management protocols, future adjustments may also be needed to make sure that cutthroat populations remain robust enough to control chub populations.*
- b. Allow commercial harvest of chubs – *Commercial harvesters have taken Utah chub from Strawberry Reservoir in the past, particularly when the numbers of small chubs were high. These smaller chubs were primarily sold as bait. During 2004 (right in the peak of chub numbers since the 1990 treatment) the harvester sold 7,798 packages of a dozen chubs (93,576 chubs) harvested from Strawberry. This number pales in comparison to the estimated 64 million eaten by cutthroat*

*predators the next year in the diet study, but does offer some help in chub control, and provided a viable commercial operation at the time. Currently these harvesters are not taking fish from Strawberry, largely because numbers of smaller chubs have diminished due to cutthroat predation, making baitfish harvesting there less profitable than elsewhere. If chub numbers increase, or another market opens up for a beneficial use of the chubs available in Strawberry, allowing these operations should be considered. However, making sure that the harvesting operations do not negatively impact sport fishing in any way is paramount. In addition, it would be crucial to make sure that these operations would not spread any unwanted aquatic invasive species or diseases through equipment being used elsewhere and actively being transported to other bodies of water.*

- c. *Spot treatments for removal of chubs – If Utah chub numbers increase to a point where other biological controls are not keeping up with their expansion, then it may be advantageous to consider chemical spot treatments to kill off large concentrations of chubs, such as spawning concentrations. It is important to realize that spot treatments alone would not be completely effective at controlling chubs, and that the biological control mechanism currently provided through cutthroat predation is more effective in the long-term. Also, such treatment efforts should be considered a last resort. However, spot treatments may allow a short-term control mechanism that may help get the system back in balance if cutthroat populations suffer, and chubs get a stronger foothold. Spot treatments with chemicals would obviously have many unwanted side effects through its non-selective nature, and many sport fish could also be killed. It would be critical to run smaller test runs to determine methods and timing that would minimize the unwanted side effects.*
- d. *Consider introducing another sterile salmonid as a predator (while maintaining the rainbow fishery) – If the Bear Lake cutthroat currently being used as a biological control mechanism to reduce chub numbers proves ineffective at some point, other salmonid species could also be considered in addition to the Bear Lake cutthroat, or as a replacement if necessitated. The issue of sterility is important if introgression with cutthroat is likely, and/or if a positive control on the newly introduced population needs to be maintained, particularly during initial trial periods. However, the Bear Lake cutthroat have proven to be extremely effective for the past 18 years, and nothing at this point would dictate a need for a change. Recent (2020) opinion surveys indicate that cutthroat trout are considered a highly desirable sportfish at Strawberry Reservoir. In addition, current public opinion dictates that the rainbow fishery be continued at Strawberry Reservoir, thereby negating the substitution of another species for the rainbows as a strong possibility. In addition, current public opinion surveys dictate that only salmonids should be considered as alternative species in Strawberry Reservoir. Only 18% of respondents indicated that they would suggest another alternative species, and over 75% of those who wanted another species indicated that it should be another salmonid. Any inclusion of other species should not be taken lightly at Strawberry Reservoir due to the sensitivity of maintaining a sustainable biological balance, as well as meeting public desires. Therefore, public opinion*

*surveys and coordination with a diverse public and agency advisory group will be part of the process.*

3. *Maintain number of 18" or greater cutthroat trout sampled in gill net surveys between 0.19 and 0.23 /net-hour in overall zone adjusted fall curtain net catch rate<sup>1</sup> – Chub numbers have declined and remained relatively low and stable since the slot limit on cutthroat was enacted back in 2003, and certain levels of predacious cutthroat (>18") have been the primary factor contributing to the initial decline and maintenance of low chub numbers (Ward et al. 2008). A significant reduction of cutthroat numbers below these levels could allow Utah chub populations to rebound to previous levels that prompted expensive chemical treatments to restore the sport fishery at Strawberry Reservoir in the past. In addition to the needed chub control provided by the cutthroat, the anglers at Strawberry Reservoir have become accustomed to catching numerous large cutthroat trout, and would like to see that continue. Though cutthroat population levels are primarily being set through gill net catch rates for chub control under this objective, modeling of the predicted angler catch rates from past gill net catch rates of cutthroat >18" indicate that anglers should experience an overall year-long catch rate of 0.37 fish per angler hour for cutthroat trout. Curtain net catch rates are relatively new (since 2017) and it will be important moving forward that the catch rates from curtain nets be calibrated with the traditional nets periodically into the future. We have 75 years' worth of traditional net data, and maintaining a connection to this past data set is crucial to put these catch rates into perspective.*

#### Strategies

- a. *Adjust size restrictions and harvest limits on cutthroat trout – In order to maintain relatively high numbers of the large (>18") cutthroat in Strawberry Reservoir, care should be taken in adjusting harvest limits based on size and numbers. Strawberry continues to be driven by harvest, and unless overall angling practices/expectations change dramatically, many anglers will continue to harvest as many fish as the regulations will allow. With the considerable pressure that Strawberry Reservoir receives, legal harvest can, and will, quickly deplete cutthroat populations. The current slot limit allowing two cutthroat under 15" and one over 22" has been very effective at providing the numbers of 18" or larger cutthroat needed for chub control since 2003.*
- b. *Promote voluntary catch and release – Since the 1990 treatment of Strawberry Reservoir the UDWR has promoted voluntarily releasing cutthroat of any size in an effort to limit the harvest of this fish. It is difficult to quantify the effect of this program, but by continuing to send the same message, the angling public will hopefully further understand the importance of the cutthroat to the biological health of the system, and also reap the benefits of having numerous large cutthroat to catch.*
- c. *Adjust stocking of cutthroat trout – Stocking is one of the most important management tools that can be manipulated at Strawberry Reservoir. Since harvest continues to be an important aspect of the fishery for as many as 50% of the anglers at Strawberry, we have to make sure that stocking keeps up with natural and angler induced mortality. Increasing the numbers stocked of one species will likely decrease the numbers stocked of other species. Hatcheries are limited in the pounds that can be produced, as well as by funding. If all things*

*remain equal, increased stocking of one species will reduce the potential to stock other species. Not only are the numbers stocked important, but size of stocked fish and timing of the stocks can be even more critical to survival. For instance, a study conducted at Strawberry Reservoir from 2017-2019 indicated that cutthroat stocked at 10" had a survival rate 3 times higher than those stocked at 8". The most recent studies did not focus on the timing of stocking, but obviously this can have ramifications as well. For instance, mid-summer periods when surface temperatures are at or above 20° C, and/or anoxic hypolimnion conditions exist, stocking would not be advised. Location, such as stocking in the tributaries, may also prove to be important in getting returns to tributaries to promote natural reproduction, and barge stocking in appropriate locations may also greatly improve survival. Obviously, there are many more potential alterations to the stocking program at Strawberry that could be tested in attempts to improve survival. It is important that managers continue to look for methods to help boost survival of stocked fish in Strawberry.*

- d. *Law enforcement emphasis – For many years one of the most common suggestions/complaints in public opinion surveys conducted at Strawberry Reservoir have been regarding law enforcement presence at Strawberry Reservoir, with most people indicating that they would like to see an increase in law enforcement presence. With the special restrictions placed on cutthroat trout in Strawberry, and the high levels of pressure Strawberry receives, it is important that an adequate law enforcement presence be maintained. The most recent compliance data tallied from road blocks indicates that 96% – 98% of the anglers are not in violation of over limits/slot limits. These levels are very comparable to other similar waters. However, there is always the need for a certain level of law enforcement presence to maintain, or even improve, those numbers. Public perception of a law enforcement presence is probably an important part of this strategy.*
- e. *Monitor cutthroat trout angler catch rates –Monitoring of angler catch rates for cutthroat trout should be continued to ensure that angler satisfaction is being met for this species. During the last 5 year-long creel surveys dating back to 1996, angler catch rates for cutthroat trout have averaged 0.41 fish per angler hour. The current objective of providing an average net catch rate of 0.21 cutthroat >18" per net hour is currently predicted to yield an angler catch rate of roughly 0.37 fish per angler hour in the creel. It is important that the overall angler catch rate for cutthroat does not fall so low as to negatively affect angler satisfaction.*

**Goal #2 - Provide a sport fishery where the species assemblage, fish size, and catch rates will appeal to its anglers**

*– The main purpose of this goal is to define the fishery that anglers would like to see at Strawberry Reservoir, and adopt any changes that may make it more appealing to as many anglers as possible. Angler catch rate targets under this goal are set for rainbow trout and Kokanee salmon, but not for cutthroat. It is important to realize that cutthroat trout are still considered one of the most important game fish species in Strawberry by anglers in recent angler opinion surveys, however, their abundance, and subsequent angler catch rates, are primarily set through levels in Goal 1, Objective 4. These levels of 18" and larger cutthroat catch rates in the gillnetting are predicted to provide creel catch rates (and sizes) similar to what anglers have become accustomed to since 2003 at Strawberry Reservoir. The latest modeling is*

*predicting an overall 0.37 cutthroat per angler hour catch rate for angler based on year-long surveys. Based on this level for cutthroat, and the following average objectives for rainbow and kokanee catch rates, anglers should experience an overall catch rate of roughly 0.6 fish per angler hour.*

#### Objectives

- <sup>1.</sup> *Maintain an average angler catch rate for rainbow trout between 0.18 and 0.25 fish per angling hour in year-long creel surveys<sup>3</sup> (or a comparable surrogate) – Year-long rainbow trout catch rates have fluctuated from 0.05 to 0.31 since 1996, with an average of 0.13 over those 5 surveys. Rainbow trout continue to be a highly sought after species at Strawberry Reservoir (most “sought after” species, and ranked highest in importance in 2020 angler opinion survey), and it was decided that there was a need to increase and stabilize the catch rate of rainbow trout to a higher average level. Obviously, this catch rate will fluctuate from year to year, and year-long creel surveys are typically only conducted once every 5 years (depending on funding and needs). Therefore, annual July only creel surveys will also be used as an indicator to track this objective. Catch rates over multiple years should be used to signify success or failure in meeting this objective.*

#### Strategies

- a. *Continue year-long comprehensive creel surveys on a five year rotation as long as funding is available – Since 1996, year-long comprehensive creel surveys have been conducted every five years at Strawberry. Supplemental funding from a creel fund housed in the Salt Lake Office of the UDWR for each of these intensive surveys has been needed. A five year rotation of these funds for a creel at Strawberry Reservoir would be desired as long as the needed funding remains intact. If catch rates of rainbow trout appear to have fallen well below the proposed objective for two to three consecutive years, it may be advantageous to implement more frequent year-long, or at least expanded, surveys to track catch rates more effectively.*
- b. *Continue conducting annual July creel surveys - Since 2015, we have conducted a July only creel survey at Strawberry Reservoir. This limited survey has been important in allowing us to track angling trends for all species on years in between the year-long surveys conducted every 5 years.*
- c. *Consider alternative survey techniques to obtain interim catch rate assessments – Other methods could be explored and used to monitor angler statistics and trends on years in between the more intensive creel surveys currently conducted every five years. Such methods could include data collected from fishing apps, social media or email surveys, and other similar methods.*
- d. *Adjust stocking of rainbow trout – Stocking is one of the most important management tools that can be manipulated at Strawberry Reservoir. Since harvest continues to be an important aspect of the fishery for as many as 50% of the anglers at Strawberry, we have to make sure that stocking keeps up with natural and angler induced mortality. Increasing the numbers stocked of one species will likely decrease the numbers stocked of other species. Hatcheries are limited in the pounds that can be produced, as well as by funding. If all things remain equal, increased stocking of one species will reduce the potential to stock other species. Not only are the numbers stocked important, but size of stocked fish and timing of the stocks can be even more critical to survival. For instance, a*

*study conducted at Strawberry Reservoir from 2017-2019 indicated that cutthroat stocked at 10" had a survival rate 3 times higher than those stocked at 8", and similar results have been noticed with rainbow stocking. The most recent studies did not focus on the timing of stocking, but obviously this can have ramifications as well. For instance, mid-summer periods when surface temperatures are at or above 20° C , and/or anoxic hypolimnion conditions exist, stocking would not be advised. Obviously, there are many more potential alterations to the stocking program at Strawberry that could be tested in attempts to improve survival. It is important that managers continue to look for methods to help boost survival of stocked fish in Strawberry.*

2. *Maintain an average summer angler catch rate of 0.125 fish per angling hour for Kokanee salmon as measured in summer (typically July) creel surveys<sup>3</sup>, with a focus on improving and stabilizing kokanee numbers in Strawberry Reservoir – Since 2015 Kokanee salmon catch rates at Strawberry Reservoir have averaged nearly 0.1 fish per hour during the July creel surveys, and have ranged from 0.05 to 0.18. It is important to note that the year-long catch rate for Kokanee is far less than this summertime average due to Kokanee being seasonal fishery (primarily summer months). Due the increasing popularity of this species with anglers at Strawberry, it was decided to work on increasing average catch rates of Kokanee salmon to help keep up with this trend. It is important to note that Kokanee populations have had a long history of fluctuating quite dramatically from year to year, and our ability to meet this objective will need to be measured through trends over multiple years. Kokanee have also proven to be a difficult species to manipulate through stocking and harvest alone. Therefore, our ability to meet and maintain this objective will be much more complicated than with other species in Strawberry Reservoir.*

#### Strategies

- a. *Adjust stocking rates - Kokanee populations at Strawberry Reservoir rely heavily on stocking, with over 50% of their numbers coming from stocked fish. Although, past data does not indicate that increased stocking always translates into more fish available to anglers, there is typically a tangible benefit from maintaining consistent stocking of these fish. Other factors (water levels, predation, natural mortality, etc.) can strongly influence Kokanee survival, but increased stocking in opportune circumstances can provide more fish when conditions permit.*
- b. *Adjust timing, size and location of Kokanee stocking – Again, Kokanee salmon have proven to be more difficult to manipulate through stocking sizes than other species at Strawberry Reservoir. Kokanee cannot simply be grown to larger sizes like other stocked species to avoid predation. Hatchery environments can cause problems with Kokanee physiology, particularly with reproduction, and Kokanee raised too long in the hatchery will mature at younger ages. Some studies have even suggested that Kokanee stocked as fry can survive better than those raised to larger sizes. Of course this can vary by system. Also, stocking location could have an impact on survival and returns to spawning locations. Typically, the majority of the Kokanee stocked into Strawberry Reservoir are stocked in the tributaries to promote returns to those tributaries for spawning purposes (particularly to the spawning trap on the Strawberry River). However, over recent years we have also stocked some smaller portions directly into the reservoir to*

*hopefully facilitate better survival (there could be some losses from outmigration in the streams), and to also promote reservoir spawning activity. Unfortunately, we do not know whether stream stocking or reservoir stocking is more advantageous for survival, or for spawning success. However, it is likely that some mix of strategies would be most advantageous due to our current limited knowledge. Continuing the stocking of roughly 75% in the tributaries and 25% in the reservoir of 3" to 4" kokanee should continue until further information is obtained. Further studies addressing these deficiencies in understanding would be advisable.*

- c. *Promote increases in natural reproduction (addressed in Goal 4, Objective 2) – Naturally reproduced Kokanee at Strawberry Reservoir have averaged about 44% of the standing population since 2017. It is important that we not only try to maintain this level of natural recruitment, but also look for ways to increase how many are produced in the system. Ongoing stream restoration efforts, stocking efforts (to promote returns to spawning habitat), and efforts to improve water quality issues can have positive impacts on spawning and recruitment.*
3. *Maintain average size of rainbows in the creel at 15" as measured in year-long creel surveys (or a comparable surrogate), while maintaining opportunities for harvest once the size objective is met<sup>3</sup> – Since 2006, rainbows in the creel at Strawberry Reservoir have averaged 15". Recent angler opinion surveys have indicated that anglers are not opposed to some restrictions to help increase the size of rainbows. However, roughly half of the anglers also indicated that they still desire to have a consistent harvest component to the fishery at Strawberry Reservoir. Therefore, any restrictions on rainbow trout harvest (size or limits) will need to consider still allowing significant harvest of rainbows to satisfy the need for a harvestable component. The rainbows at Strawberry have provided the main harvest component in recent years due to the restrictive nature of the current slot limit on cutthroat. Surveys have also long documented that rainbow trout remain a favorite component of the catch at Strawberry.*

#### Strategies

- a. *Adjust size and timing of rainbow stocking as necessary – Recent studies conducted on cutthroat (2017-2019) have indicated that the stocking of 10" fish can be very effective at maximizing survival of stocked fish, while considering returns from pounds stocked. Therefore, stocking of 10" rainbows should be continued as long as it remains effective, with a mix of fall and spring stocks to provide harvestable fish at different times of the year. It is critical to continually monitor the effectiveness of the stocks, and future adjustments in size and timing of these stocks may be needed.*
- b. *If average size and/or condition drops due to competition, implement strategies for chub control found in Goal 1, Objective 2 – Competition between rainbow trout and Utah chubs has been well documented at Strawberry Reservoir (and elsewhere), and has prompted the past rotenone treatments there. If chubs become a problem again in the fishery, it will likely first be seen in rainbow growth and survival.*
- c. *Publicize growth rate as a way to promote catch and release – Growth rates of the rainbows at Strawberry are very good, and a slight change in the harvest patterns of anglers can have huge impacts on survival and size potential of the fish there.*

*Strawberry continues to be driven by harvest and the promoting of voluntary catch and release with the promise of larger rainbows in the near future may alter some anglers harvest habits. The effectiveness of these types of programs is difficult to quantify, but they may help without much additional effort or cost.*

- d. Apply harvest restrictions (size and/or numbers) as needed – *Since Strawberry Reservoir continues to be largely driven by harvest (anglers control populations of sportfish), restricting harvest remains one of the most effective means of controlling size and numbers of sportfish available. However, harvest in general remains important to roughly half of the anglers at Strawberry, and severe reductions in harvest potential will impact those anglers and their desire to fish at Strawberry Reservoir. Care should be taken to ensure that restrictions designed to increase the average size of the rainbows does not overly restrict the harvest potential at Strawberry Reservoir. However, a slight change in angler harvest patterns could have relatively large changes in the average size of rainbows available. Any proposed regulation changes on rainbows aimed at increasing the average size should be modeled as to the expected outcomes of harvest potential as well as potential size increases, and then run through public opinion surveys before being run through the RAC and Wildlife Board.*

**Goal #3 - Ensure a variety of fishing experiences** – *Strawberry Reservoir receives as much as 1.5 million angler hours on an annual basis, and remains one of the top sport fisheries in Utah. It is critical that a fishery be provided at Strawberry that will appeal to the largest group of anglers possible, which means providing a variety of opportunities. In addition, it is important to make sure that all anglers, and potential anglers, are aware of the opportunities available.*

**Objectives**

1. Maintain a minimum fishing pressure of 1 million angler-hours annually, using a minimum of 200,000 angler hours during annual July creel surveys as an indicator of success between full-year surveys<sup>3</sup>. Falling below these levels for more than two consecutive years triggers further surveys and other actions – *Strawberry has sustained an average annual fishing pressure of just over 1.1 million angler hours since the 1990 treatment, providing an obtainable, and sustainable, goal for pressure. Current population trends in the state of Utah are only increasing, and future projections only show this trend continuing. Therefore, falling below 1 million angler hours would indicate that something has changed in angling habits, desires, and/or the fishery itself to keep people from wanting to fish there.*

**Strategies**

- a. Focus on new recruitment – *Organize and promote activities and events that focus on recruiting new anglers of all ages to the sport*
- b. Advertisement/outreach – *Continue, and possibly increase effort, in advertising events and opportunities such as the following non-comprehensive list:*
  - i. *Cast for Kids, disabled veterans fishing event, ice fishing clinics, etc.*
  - ii. *Publicize rainbow availability and size*
  - iii. *Out of state campaign*
  - iv. *Quality aspect (cutthroat trout)*
  - v. *Promote kokanee angling opportunities*

- vi. *Publicize and promote watchable wildlife events (e.g. kokanee and cutthroat events)*
  - vii. *Web based weather and wildlife cameras*
  - c. Provide an appealing fishing experience to draw anglers (see previous objectives) – *If a highly desirable fishery can be developed, it is likely that people will use it. Many of the Objectives and Strategies outlined under Goal 2 provide the means to help accomplish this.*
  - d. Improve/maintain fishing-related recreational experiences at Strawberry – *For many, fishing at Strawberry Reservoir means more than just catching fish. Camping, ATV riding, hunting, wildlife viewing, and aesthetics/setting are also important to the overall experience. It is important that managers recognize the interactions of these activities, and that a management decision at one level can affect other areas as well. It is critical that all resource managers maintain a high level of cooperation and communication in the Strawberry Valley to ensure that all types of recreational activities are considered in management decisions.*
  - e. Make Strawberry more user friendly – *Make sure that fishing at Strawberry Reservoir does not seem too difficult or inconvenient for the largest possible group of potential anglers. Information availability, opportunities, fees, regulations, and facilities need to be geared towards making people comfortable with the experience. It is of obvious importance that good working relationships be developed and maintained with all partnering agencies and groups to make sure that the needs of users are being met. Continued support and involvement with the Friends of Strawberry Valley working group is crucial in maintaining these relationships.*
  - f. Explore opportunities for increasing and/or improving access for shore fishing (general public and disabled anglers) and for launching personal watercraft, consistent with Forest Plan – *Opportunities to increase and/or improve shore angling and use of small personal watercraft (e.g. float tubes and personal pontoon crafts) need to be explored. Strawberry continues to be a boat oriented fishery during ice-off seasons, and expansion of shore angling and non-motorized watercraft opportunities (including dissemination of information) has great potential to draw more anglers to Strawberry. Included in this concept, is the idea of providing facilities for disabled anglers. Any expansion and/or improvement would obviously have to be taken through the proper channels (typically including the Forest Service), as they are the land managers over the vast majority of the land around Strawberry Reservoir.*
2. Maintain a minimum of 150,000 ice angler-hours per year as measured in creel surveys when ice and snow conditions allow<sup>3</sup>. Alternate representative methods should be employed on year's in-between year-long creel surveys – *During the last four creel surveys since 2001, Strawberry has sustained an average of 188,000 hours of ice fishing pressure. Ice conditions at Strawberry Reservoir remain relatively stable and predictable from year to year compared to many other large bodies of water in Utah due to its high elevation and frequent cold air inversions that settle in the valley. Ice angling was identified as one of the most promising areas to expand angling opportunities to a wide array of the public due to the lack of a need for expensive equipment (e.g. boat) and because Strawberry Reservoir could sustain more pressure provided that adequate*

*access can be maintained and even expanded upon. It is important to note, however, that even Strawberry Reservoir can have poor ice conditions and heavy snow conditions on some years, typically with regard to heavy snowfall that makes access around the ice difficult. Due to these variable conditions, it is important to take ice and snow conditions into account when evaluating the success of this objective. In addition, annual creel surveys have traditionally only been conducted on a 5 year rotating basis, therefore, it will be important to develop alternative methods on in-between years to track pressure during winter months that could be correlated to the pressure level set in the plan. If we fall below this objective for more than two or three consecutive years, actions should be taken to try and evaluate and address potential bottlenecks.*

#### Strategies

- a. *Improve access and maintain access authorizations – Currently UDWR coordinates with Utah State Parks and Recreation, Strawberry Bay Marina, Wasatch County and the US Forest Service to keep angler parking areas open during the winter. The parking areas currently provided during the winter are often filled to capacity on busy days, and any efforts to expand ice angling opportunities would need to address access. Annually the UDWR is obligated to compete for funding to help pay for snow removal efforts at angler parking areas. This funding is in jeopardy of not being funded on any given year. If this funding were to not get approved for any reason, ice angling opportunities would be severely limited at Strawberry Reservoir. Managers at all coordinating agencies should always be looking for additional opportunities to help fund this vital service.*
  - b. *Explore opportunities to increase facilities to support more ice fishing (parking, restrooms, trash, etc.) - Look for opportunities to increase parking areas such as development of the proposed Chicken Creek East boat ramp and parking area. If currently proposed developments (or others) that provide winter access come to fruition, look for opportunities to provide ice angler parking areas in conjunction with their efforts. Any expansion of parking/access would obviously need to address other facilities such as restroom and trash services.*
  - c. *Promote opportunities through advertising and events – Past public ice angling events have met with tremendous success, and similar events that promote the sport to the new angler should be explored.*
  - d. *Develop alternate methods for tracking winter fishing pressure at Strawberry Reservoir – Year-long creel surveys have only been conducted every 5 years since 1996, and in order to track our ability to meet this objective, it will be important to find alternate methods for tracking fishing pressure during winter months that could be correlated to our estimates obtained through the creel surveys. Some possibilities could include: parking lot counts, short duration creels, online surveys, fishing apps, etc. However, it would be important to correlate these estimates to actual counts to verify that they could be used as a surrogate.*
3. *Take action to provide additional fishing opportunities on Strawberry tributaries – Opportunities to fish the tributaries to Strawberry Reservoir have been much more limited than they were prior to the 1990 treatment. Spawning closures, catch and release restrictions, and special gear restrictions have been used to protect spawning and*

*rearing of naturally produced fish in the tributaries. And though many of these goals are still relevant (see Goal 4), managers should explore the potential to promote and expand fishing opportunities on the tributaries.*

Strategies

- a. Remove some of the Kokanee spawning closures – *In some instances it may be possible to allow more fishing opportunities on certain streams during the current Kokanee spawning closure from September 1<sup>st</sup> to the second Saturday of October. The need for these closures has largely gone away over the years. Stream restoration efforts have successfully brought back healthy stands of willows along many of the tributaries where Kokanee used to spawn. As a result, beaver activity has significantly increased in many areas, which greatly limits the ability of Kokanee to migrate into some areas that they used to be able to access. Therefore, opening these sections up to angling during the Kokanee spawn will not have negative impacts on Kokanee spawning success. Careful monitoring of potential additional impacts to spawning and recruitment should be incorporated into any loosening of the regulations on the tributaries.*
  - b. Monitor tributaries (fish populations and water quality) – *Continue careful monitoring of fish populations and water quality valley-wide, including agreements between UDWR and UDWQ (EPA QAPP – Strawberry River Phase IV, 2012). This information would provide the basis for ascertaining the possibilities of allowing more angling opportunities on the tributaries.*
4. Enhance non-angling fishery related opportunities (viewing events, educational opportunities, and outreach) with angler recruitment focus – *Not all visitors who come to the Strawberry Valley are anglers. Through good education and information dissemination, non-anglers can also gain an appreciation for the fishery resources at Strawberry, and may potentially gain an interest in angling through these activities. With the connection of the UDWR fish trap facility to the USFS Visitors Center at Strawberry, there is a unique opportunity to connect many non-anglers to the area and resources.*

Strategies

- a. Fish viewing events – *Continue an emphasis on activities such as the Kokanee and cutthroat viewing days. Thousands of people come through the Visitors Center and fish trap each year to see the spawning fish. Other opportunities should also be explored to connect people at large with the resources. Providing online viewing opportunities should also be considered. It is imperative that a good relationship be fostered with the USFS, and that the facilities (such as the boardwalk and trap) are maintained to keep these valuable activities ongoing.*
- b. Educational tours – *Continue providing educational tours for a wide variety of people. Each year numerous tours/lectures on spawning and egg taking operations, stream restoration, natural resources and management, and fishing have been conducted for groups ranging from grade school children to the Governor, US Senators and heads of Federal agencies. Such activities provide valuable information and education that help not only in promoting the resource at Strawberry Reservoir, but in a broader sense as well.*

5. Ensure and enhance opportunities for all angler types and methods legally allowed at Strawberry Reservoir. – *Over the decades, anglers have become accustomed to being able to fish at Strawberry Reservoir regardless of their personal fishing styles and techniques. It is important that we recognize that Strawberry has a long history of being open and appealing to a wide variety of anglers, and that any further restrictions on methods or angling types could have a very negative impact on large numbers of anglers. In addition, it will be important to make sure that opportunities for all angling types and methods are not restricted by lack of amenities and facilities.*

#### Strategies

- a. Angler Opinion Surveys – *Managers need to ensure that angler opinion surveys are conducted on a regular basis (3-5 years for intensive surveys, and more frequently for on-reservoir or topic specific surveys). Without this critical information, it is quite impossible to keep up with current public perceptions and desires for this highly utilized fishery. These surveys should drive the discussion for any future revisions to the management plan.*
- b. Public Outreach – *It is important to keep in mind that as information is disseminated to the public about Strawberry Reservoir, that a conscious effort is made to make sure the public is aware of the opportunities for all anglers at this valuable resource. This would be particularly important if any future regulation changes were proposed. The intent of any future regulations or restrictions should carefully weigh the pros and cons of how these changes could be perceived by all types of anglers (and methods of angling), and should not unduly restrict or limit angling methods or types of anglers.*
- c. Future development – *As future projects and development occurs in the Strawberry Valley, fisheries managers should work closely with developers and land management agencies to help ensure that these projects will benefit a wide variety of fishery and wildlife users. These projects should include analyses of the limitations and needs for each type and method of angling. Considerations for ADA access should also be included in this.*

Goal #4 - Improve natural reproduction of cutthroat trout and Kokanee salmon populations – *Promoting natural reproduction at Strawberry Reservoir has been one of the primary goals since prior to the 1990 treatment. The 1987 management plan for Strawberry identified some lofty goals of natural reproduction (10 million fry produced each year) that were difficult for managers to track the progress of. However, the general idea of enhancing natural reproduction remains a high priority, largely based on the data that on average 32% of the cutthroat and 43% of the kokanee in Strawberry have come from natural reproduction since 1993.*

#### Objectives

1. Maintain average annual recruitment of Age I cutthroat trout at 0.033 fish per net hour, with a focus on increasing this level <sup>1</sup> – *Since 2017, and the inception of our more robust reservoir sampling protocols, we have documented an average catch rate in our nets of 0.033 age 1 cutthroat per net hour (adjusted by strata and reservoir volumes) coming from natural recruitment. Moving forward it is important that this level of natural recruitment be maintained, with additional efforts being taken to increase this level.*

#### Strategies

- a. Stream restoration – *Millions of dollars, and a considerable amount of effort, have been spent in attempts to rehabilitate degraded tributaries in the Strawberry Valley since 1990. It is impossible to determine how much affect many of the past efforts have had in increasing natural reproduction, but current efforts have a monitoring component included that should help quantify the effects of the restoration efforts. However, it does seem intuitive, and is backed by considerable research, that certain improvements to stream quality does have a positive impact on spawning and recruitment of fish. Efforts to improve stream quality for fish spawning and recruitment should be continued. It is important to note that some of the desired outcomes from these restoration efforts will not be noticed immediately. For instance, one of our most limiting factors in recruitment on the Strawberry River is elevated temperatures. Restoration efforts on this stream largely focused on narrowing and stabilizing the channel, and providing more woody vegetation for shading (which was previously non-existent in most areas). It will take time for this woody vegetation to establish sufficiently to provide the needed shading for significant stream temperature reductions to occur.*
  - b. Improve/increase water flows – *Water is obviously one of the most limiting factors in fish populations. If options arise where water flow regimes can be improved they should be pursued. For instance, studies are currently being undertaken to find out why some valley streams dry up during late summer. Once dewatered reaches are identified and causes of water loss are found, measures to reverse these causes should be undertaken if feasible.*
  - c. Promote stream spawning – *Managers should look for opportunities to promote stream spawning activity. For instance, allowing cutthroat to bypass the trap during spawning migrations, looking into imprinting strategies, and stocking the streams to promote natural imprinting of stocked fish should all be considered. Continual monitoring and selective removal of fish migration barriers, such as beaver dams, is of obvious importance in critical areas as well.*
  - d. Continue Fish Marking Efforts – *Managers at Strawberry Reservoir have been marking cutthroat trout stocks since the 1990 treatment. These methods have been recently refined, and improved upon, and all of our stocked cutthroat can be marked with minimal effort (<3 hours per 400,000 fish) and cost. Yet the amount of additional information gained from this effort far out weights the minimal costs. It would be extremely difficult (and far more expensive) to try and track natural recruitment in Strawberry Reservoir without this marking effort.*
  - e. *Implement water quality improvement recommendations contained in “Strawberry Watershed Restoration Report, Strawberry Watershed Restoration Report Action Plan and Strawberry Reservoir TMDL Study (UDEQ, 2005).*
2. Maintain an average of 0.15 Kokanee per net hour from natural reproduction, with a focus on increasing this level. – *Kokanee salmon have increased in popularity among many anglers during the last 10 years or so. Even though they do not comprise a large proportion of the overall annual catch in the year-long creel (about 7% on good years), there is a considerable amount of interest in pursuing them during summer months (over 1/3 of anglers are actively pursuing Kokanee salmon in July at Strawberry). Managers were not able to effectively monitor Kokanee salmon populations in Strawberry Reservoir*

*until 2017 when new netting protocols were adopted which now provides a very robust sample of all fishes in all strata of the reservoir. Naturally recruited Kokanee have comprised nearly 45% of the Kokanee population in Strawberry Reservoir on average since 2017, and this equates to an average catch rate of 0.15 per net hour in the fall nets. These naturally recruited Kokanee are vital to the success of the Kokanee fishery at Strawberry Reservoir, and efforts should be taken to maintain, and even improve upon, natural recruitment potential for these fish. Not only do kokanee provide an important sport fish opportunity at Strawberry, but they also provide an extremely valuable watchable wildlife opportunity (see Goal 3, Objective 4).*

#### Strategies

- a. Investigate/monitor lake spawning and stream spawning activity– *Managers at Strawberry currently have very little understanding as to the successes of lake spawning vs stream spawning activity in Kokanee salmon at Strawberry Reservoir. Due to our long-term hatchery marking efforts of Kokanee in Strawberry we do know what percentage of the Kokanee population comes from natural recruitment annually, but we do not know where most of this recruitment comes from. Stream surveys have provided some information on numbers of stream spawners, and recent reservoir population estimates could provide some clues as to how many reservoir spawners we may have, but the spawning successes of each group remains unknown. Efforts to look at natal origins through microchemistry during research conducted from 2017 to 2019 failed to provide any clues due to the microchemistry of the streams and the reservoir being too close in signatures to evaluate distinctions. Further efforts should be taken to look for other methods to evaluate reservoir and stream spawning successes in Kokanee salmon at Strawberry Reservoir.*
- b. Explore stocking strategies – *Currently most of the kokanee stocked into Strawberry are stocked in late April or May, and they are stocked into the tributaries to promote returns to those tributaries. In recent years managers have stocked some of the kokanee directly into the reservoir in certain areas to try and promote lake spawning activity. In addition, some kokanee have been stocked in January as swim-up fry. The level of success of each of these varied methods and strategies has been difficult to quantify. Managers should look for ways to try and determine the successes and failures of various stocking strategies to try and maximize the returns on stocked kokanee. These efforts should be undertaken in conjunction with spawning location studies (see Goal 4, Objective 2, Strategy a). In addition to the timing, sizes and locations of stocking, managers should also continually evaluate the numbers being stocked as a way of manipulating natural spawning activity. For instance, a high proportion of the stream spawning population (about 60%) can come from stocked individuals. Therefore, the bulk of our natural recruitment can come from stocked kokanee. Again, balancing stream and reservoir stocking to areas that can produce the greatest returns to natural recruitment could bolster populations. It is also important to note that natural recruitment can vary greatly from year-to-year (<5% of the population to nearly 80%), and stocking can provide much needed stability to populations in years with poor natural recruitment.*
- c. Balance egg takes from Strawberry Reservoir – *Currently, the vast majority of the state-wide Kokanee egg production comes from spawning operations at Strawberry Reservoir, typically with the smaller fraction of these eggs taken from Strawberry,*

*actually returning to Strawberry. It is important to make sure that we do not unduly compromise the stability of future spawning activity by not returning enough of the eggs taken back to the system that produces them. In addition, all of the eggs taken from Kokanee egg taking operations at Strawberry that are diverted to other waters will impact natural recruitment potential at Strawberry.*

- d. *Provide spawning access/habitat for Kokanee salmon – Lower water levels during the fall can make spawning migrations up Strawberry Reservoir tributaries difficult for Kokanee salmon. Beaver dams are typically one of the biggest barriers for Kokanee migrations in the tributaries, and constant monitoring and dam removal is necessary to provide access to spawning habitat. The successes of our stream restoration efforts have created some issues for Kokanee migration. Managers should look for opportunities to provide access to the best habitat that can logistically be kept open for migration. Also, as mentioned in Goal 4, Objective 1, stream restoration activities can provide better spawning habitat, and these efforts should be continued.*
- f. *Continue Kokanee salmon marking efforts at Strawberry Reservoir –Marking operations of stocked Kokanee at Strawberry Reservoir has changed in recent years with the conversion from oxytetracycline marking to external colored dye marking. These dye marking methods have proven to be almost as effective, with the caveat that spawning Kokanee will lose about 12% of these external marks when they absorb their scales. Without these marking operations, it would be much more difficult to track natural recruitment in the system. These marking methods have become very streamlined. Very little time and effort goes into the marking of these fish, yet the amount of data obtained from these marks has become invaluable by allowing us to more effectively and efficiently track numbers, growth, survival, and natural recruitment.*
- g. *Implement water quality improvement recommendations contained in “Strawberry Watershed Restoration Report, Strawberry Watershed Restoration Report Action Plan and Strawberry Reservoir TMDL Study (UDEQ, 2005).*

<sup>1</sup> *Based on a three year moving average from data collected in the fall gillnetting at Strawberry Reservoir (gillnetting must remain consistent with past methods and effort). Some numbers have simply been adjusted from the old traditional nets to curtain netting conducted since 2017, and may need future adjustment as curtain net trend lines expand.*

<sup>2</sup> *Utah Water Quality Standards(Utah Administrative Code R317-2):*

*<http://www.rules.utah.gov/publicat/code/r317/r317-002.htm>*

<sup>3</sup> *Based on the comprehensive year-long creel surveys which have been conducted every five years at Strawberry Reservoir since 1996, combined with data from limited surveys conducted in the interim years (Thomas and Chamberlain, 2000). Future surveys are dependent on available funding.*

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