SUMMARY OF DIDSON OPERATIONS IN FOUR SOUTHERN CALIFORNIA STREAMS 2011-2013

Prepared by:
Heidi Block, Sam Bankston, and Patrick Riparetti

Pacific States Marine Fisheries Commission and
California Department of Fish and Wildlife

INTRODUCTION

Southern California steelhead trout, *Oncorhynchus mykiss* (*O. mykiss*), were listed as endangered under the Federal Endangered Species Act in 1997. Since then, limited monitoring and research programs have been implemented to determine the population size of the Southern California steelhead in accordance with the National Marine Fisheries Service Southern California Steelhead Recovery Plan (NMFS 2012). Monitoring efforts for this species are complicated by low population levels and the incredibly flashy nature of southern California streams. In order to determine a run size for these fish, a method is required that allows for monitoring under varying stream conditions (Adams et al. 2011).

Dual Frequency Identification Sonar (DIDSON) is a high resolution imaging sonar that has been used in a variety of locations to determine salmonid run size where other methods are not appropriate (Belcher et al. 2001, Holmes et al. 2006, Johnson et al. 2006, Burwen et al. 2007, Pipal et al. 2012). DIDSON units are now being used to monitor Southern California streams, to meet the need for a wider range of monitoring conditions. There are several advantages of using DIDSON units to monitor southern California streams. One advantage is the ability to use these units in high flow events when weirs would need to be removed, resulting in the potential to miss migrating fish. The DIDSON also does not impact the natural behavior of fish or other wildlife unlike weirs, which require fish to be handled and where natural movement around the trap is impaired. DIDSON units can also be used in turbid water where video cameras would not be able to collect useful data. DIDSON units also provide real time video-like images that allow for behavior observations and some species identification.

This DIDSON monitoring project in Southern California is relatively new, starting in 2011 and is part of the Department of Fish and Wildlife's California Coastal Monitoring Program (DFW-CCMP). Monitoring began in Core 1 systems, as defined in the National Marine Fisheries Service (NMFS) Southern Steelhead Recovery Plan (2012). DIDSON sites were chosen based on location within the watershed, security, and accessibility.

DIDSON cameras were deployed during storm events and for training from 2011-2013 in four Southern California Streams. These streams, from North to South, were Salsipuedes Creek (winter 2012-2013), Arroyo Hondo Creek (winter 2011-2012), Ventura River (winter 2012-2013), and Topanga Creek (winters 2011-2012 and 2012-2013).

METHODS

Standard DIDSON units were used in all stream deployments. DIDSON units are sonar cameras that send out acoustic pulses in 48 or 96 beams to create real-time images from the returned signatures. The standard DIDSON units operate at either 1.8MHz or 1.1 MHz, depending on whether the unit is run in high or low frequency mode. For all of our deployments, the unit was run in high frequency mode in order to have the best quality images for species identification.

All DIDSON footage was analyzed using the DIDSON software v 5.25. When deployed the DIDSON units were set to record continuously in 20min files. Significant events, such as trout movement, are often spaced far apart in the DIDSON recordings. In order to reduce the search time associated with these rare events, a built-in analytical tool called an Echogram was used. Echograms graphically represent an objects movement over time. All parameters remained at default values, which provided adequate sensitivity to detect target objects.

When potential targets were identified, the images of fish and other animals were measured using the box measuring technique in the DIDSON control and display software. For this technique, a box is placed around the object and the size of either the width of the box is used or the diagonal depending on the object orientation. We determined fish sizes using the average of the sizes taken from the 3 best images of the fish.

In DIDSON images, pixel size is affected by the window length as well as the range of the object you are viewing. It is important to consider pixel size when sizing DIDSON images because when pixel size is large there is a greater potential for error. Cross-range pixel size is affected by the distance, in meters, the object is from the sonar (R) and calculated using the equation: 0.5R/100. For example, a fish that is 5m from the sonar will have a cross range pixel size of 2.5 cm (0.5*500cm/100). This means that when sizing a fish that is 5m from the sonar unit there can be up to 5cm of error. This type of error is decreased when fish are closer to the sonar unit.

DIDSON units were deployed in streams during winter storms when the potential for connectivity with the Pacific Ocean was expected and steelhead could potentially migrate into the streams. In addition, several test and training deployments were conducted. There were a very limited number of events between October 2011 and April 2013, due to the low rainfall levels of the past two years.

RESULTS

During the DIDSON deployments over the last two winters there have been no adult anadromous steelhead images captured. This is largely due to the drought conditions that have been present in Southern California since 2010 (Figure 1). In the 2012 water year, Santa Barbara received 11.62 inches of rainfall which is 64% of normal. Santa Barbara Received 8.86 inches of rain, which is 49% of normal in 2013. Lompoc had 10.62 inches in 2012 and 7.16 inches in 2013 (72% and 48% of normal respectively) (Santa Barbara County Public works website). Downtown Ventura received 8.86 inches of rain in the 2012 water year (60% of normal) and 6.46 inches in 2013 (44% of normal) (Ventura County Public works website).

O. mykiss were observed in the monitored streams. These fish were determined to be either resident trout or smolts due to their behavior and size. In addition to trout, small other native fish, frogs, turtles, crayfish, ducks, and beavers were observed in the DIDSON footage.

Descriptions of the results from each deployment are included below.

Topanga Creek, April 2012 and January 2013:
DIDSON units were deployed in Topanga Creek in April 2012 and January 2013. During both deployments, the mobile solar trailer was used to power the DIDSON (see Figure 2). These deployments took place just upstream, approximately 40m, of an antenna array used to determine if tagged fish are moving in and out of the system (operated by the Resource Conservation District of the Santa Monica Mountains).

During the April 2012 deployment there were several possible out migrating *O. mykiss* smolts observed. There were some technical difficulties during this deployment leading to hours of unusable footage. During this deployment there were 5 total fish observations that were clearly trout, 2 upstream and 3 downstream on 4/12/2012. The DIDSON picked up fish passing at 19:40 (fish went downstream and then upstream), 19:46 (fish went downstream and then upstream), and then again at 19:51 (fish moved downstream). The observed fish measured about 20 cm, ranging from 19 to 23 cm. We believe this to be one fish traveling back and forth in front of the DIDSON before ultimately moving downstream, however it is possible that this could be multiple fish.

During this deployment one tagged fish was picked up moving downstream by the antenna array. This fish was observed moving downstream at 19:54 on 4/12/2012. We believe this is the same fish observed on the DIDSON moving downstream at 19:51 on 4/12/2012. The tagged fish was originally tagged on 11/14/2011 and was 14.0cm FL, the fish was then re-captured on 3/20/2012 and was 16.4cm FL (data from the Resource Conservation District of the Santa Monica Mountains). The fish seen moving downstream on the DIDSON at 19:51, 3 minutes before the tagged fish was picked up by the antenna, measured 20.0cm TL. Due to the closeness in time and size we believe the tagged fish was the same fish picked up by the DIDSON at 19:51 going downstream.

In addition to the trout observed, there were chorus frogs, crayfish, ducks, and unidentified small fish observed in the DIDSON footage in April 2012. The chorus frogs (Figure 3) and small fish were most active during the night time hours.

During the 2013 deployment the water was very low at the DIDSON site, less than one foot deep (Figure 2). No *O. mykiss* were observed during the January 2013 deployment. However, during this deployment crayfish, small fish such as chub and stickleback and ducks were observed. Chorus frogs were not present during the January deployment.

Arroyo Hondo Creek, March-April 2012:
A camera was deployed in Arroyo Hondo in March and April of 2012. The mobile solar trailer was used for this deployment. Four trout were observed ranging in size from 21 to 32cm (Figure 4). These deployments occurred in a pool where fish were seen milling. In addition to the trout, a California red legged frog, *Rana draytonii*, was observed. It was determined to be a red legged frog based on its size and the absence of bullfrogs in this watershed (Figure 4).

Salsipuedes Creek, January-March 2013:
Four deployments in total occurred at Salsipuedes Creek from January-March 2013. This site has a dedicated electrical circuit as the power source. The first two deployments had power related issues, where power outages were causing the DIDSON unit to turn off. The second two deployments went smoothly after an electrician was brought in to identify and fix the problem.

Following selection of the site on Salsipuedes Creek, beavers moved into the area and created dams upstream and downstream of the DIDSON location. Due to low water levels it was determined that fish passage was affected and had the potential to limit access by migrating steelhead (Figure 5). Despite this challenge the site was monitored during test deployments as well as storm events when it was possible for higher flows over the dams would make passage possible or had the potential to washed out the beaver dams; although no wash outs occur.

Due to the presence of the two beaver dams on either side of the DIDSON site, we observed a lot of beaver activity during our deployments in the Creek. As expected, the beavers were the most active during the nighttime hours from 6 pm to 6 am (Figures 6 and 7). Beavers were seen pulling large branches back and forth in front of the DIDSON throughout the night. Based on size estimations from the DIDSON, we believe there are 2 beavers in this area, one approximately 60cm long, and one approximately 80cm long. One beaver was reported dead near the end of March. We can not give an exact estimate for the number of times the beavers travel between the two dams because it is possible that they traveled over land behind the DIDSON unit.

In addition to the beavers at this site, we also observed many small minnows, chorus frogs, crayfish, as well as resident *O. mykiss.* The *O. mykiss* at this site are considered resident at this point because passage upstream from the ocean was not possible due to low flow levels and the height of the lower beaver dam. We observed 2 *O. mykiss* at this site, one that measured 19cm, and one that was 15cm. These fish were seen multiple times, but determined to be the same individuals based on their behavior, size, and location between the two beaver dams.

Ventura River, March-April 2013:

A DIDSON unit was deployed 3 times at the Ventura River, once for a 24-hour test deployment from March 4 to March 5 2013, and twice when flows were expected to be higher, March 30- April 1, 2013 and April 15-17, 2013.

During the first test deployment, we wanted to determine if any electrical problems were present at the site, or if there were any issues with the DIDSON placement. Like the Salsipuedes site, there is a dedicated electrical circuit powering the DIDSON unit. During this deployment, multiple common carp, *Cyprinus carpio*, were seen in the DIDSON footage, which was verified by direct observation during and after the deployment. Carp could be distinguished from trout in the DIDSON footage through their behavior, and visibility/morphology of pectoral fins (Figure 8). Two trout were also seen, and were estimated to be 17 cm and 30 cm long. The fish were determined to be *O. mykiss* based on their behavior and size. It is impossible to tell at this point whether these fish were steelhead or resident trout. The one 17 cm trout, which could have been an out migrating smolt based on it's size, was seen to swim downstream and then back upstream resulting in zero net movement. The larger 30 cm trout was also seen to swim back and forth in front of the camera with no net movement.

The second deployment, March 30-April 1, 2013, took place when a storm was expected to come through and raise water levels. Unfortunately, very little rain fell during this event. Similar to the previous deployment, several carp were observed during the deployment as well as *O. mykiss*. The *O. mykiss* was determined to be about 23 cm long, and was seen swimming up and down stream repeatedly (Figure 8).

The third deployment, April 15-17, 2013, was in response to a slight increase in the flow at the site. As in the previous deployments, carp were seen throughout the nighttime hours and at least one *O. mykiss* was observed swimming back and forth in front of the DIDSON. The *O. mykiss* observed during this deployment was measured at around 23 cm. It is likely that this is the same individual that was seen during the March 30-April 1 deployment.

In addition to the fish seen at this site, we also observed turtles (Figure 8), chorus frogs, and birds swimming on the surface.

DISCUSSION

The DIDSON deployments from 2011 to 2013 provided valuable insight into DIDSON operations at these 4 locations. Over this time period, sites were developed as permanent monitoring location, staff members were trained, DIDSON units were deployed, and DIDSON footage was analyzed.

Three sites were fully developed for DIDSON deployment: Salsipuedes Creek, Ventura River, and Topanga Creek. At Salsipuedes Creek, a job box was installed with access to electrical outlets, during deployment all electrical equipment is kept in the job box, which protects if from rain and theft. In addition, a trail was cut and stairs were installed to allow for safe access to the creek. In addition, track mounting system was devised to allow for the movement of the DIDSON in and out of Salsipuedes creek from a safe distance up the bank. The Ventura River site is located on Ojai Valley Sanitary District property. An 8 foot by 10 foot storage container has been moved to the site, which has electricity and provides a dry location for equipment and staff during deployments. The Topanga Creek site was finally located on State Park property about a tenth of a mile upstream of the lagoon. Due a current lack of power at the site, the DIDSON's power needs are supplied by use of a mobile solar trailer. The advantage here is that we will be able to relocate the site if it proves not to be a good location.

The deployments over the last two winters have allowed us to accumulate many images of species located within these watersheds. We have observed and recorded *O. mykiss,* common carp, native small fish (likely chub and/or stickleback), chorus frogs, red legged frog, crayfish, turtles, and beavers. Unfortunately due to low levels of rainfall the last two winters, we have not seen any adult steelhead entering these streams. The images of other species, besides adult steelhead, will help with species identification using the DIDSON units in the future.

Over past two winters, we have had learned what works and what doesn't work in our stream systems and identified several challenges that will need to be addressed in order for us to be as successful as possible. One of these challenges is the need to keep people on-site during the deployments due to the proximity of the sites to urban centers. Vandalism and theft is a constant worry for us. On one occasion, the mobile solar trailer was damaged by vandals while in one of our more remote locations. Due to this reality, we will need to find funding for more staff, preferably permanent CDFW employees, as well as develop a cadre of volunteers to assist us. We did get help from several University of California Santa Barbara students on at least two of the deployments.

Another challenge has been developing mounting systems for the DIDSON units. We did a fairly exhaustive search, and with a few notable exceptions, found that there was little information available about what type of mounting systems are being deployed in other locations or how to build them. Even information on what needs to be considered when designing a mounting system in terms of localized site conditions was limited. Given this lack, each CDFW Regional Coastal Monitoring Program is left to its own devices, which is not efficient or cost effective. It would be helpful if the CDFW developed a central repository for this type of information, which would include design drawings and images, parts lists and the site conditions the various mounts were designed to accommodate.

Another issue that isn't a challenge currently but will likely become one in the future is the long term data storage. We currently use several external hard drives for storage but this is not a good long term solution since they are expensive and other more economical solutions are available now. However, this is a topic that concerns all DIDSON users and the Department would be wise to get out in front of this issue and set up protocols for storage and handling of our data sets.

With the site development, species images, and data analysis training we are now better prepared for more efficient deployments during the 2013-2014 winter season. Hopefully with increased rainfall next season, we will see adult steelhead returning to these streams and be able to collect the data necessary for determining population levels for Southern California steelhead.

REFERENCES

Adams, P.B., L.B. Boydstun, S.P. Gallagher, M.K. Lacy, T. McDonald, and K.E. Shaffer. 2011. California Coastal Salmonid Population Monitoring: Strategy, Design, and Methods. California Department of Fish and Game. Fish Bulletin (180).

Belcher, E.O., B. Matsuyama, and G.M. Trimble. 2001. Object identification with acoustic lenses. Pages 6–11 *in* Oceans 2001 MTS/IEEE (Marine Technology Society/Institute of Electrical and Electronics Engineers) an ocean odyssey: conference proceedings, volume 1. MTS/IEEE, New York.

Burwen, D.L., S.J. Fleischman, and J.D. Miller. 2007. Evaluation of a dual-frequency imaging sonar for detecting and estimating the size of migrating salmon. Alaska Department of Fish and Game, Fishery Data Series No. 07-44, Anchorage.

Holmes, J. A., G. M. W. Cronkite, H. J. Enzenhofer, and T. J. Mulligan. 2006. Accuracy and precision of fish-count data from a "dual-frequency identification sonar" (DIDSON) imaging system. ICES Journal of Marine Science 63:543–555.

Johnson, P., B. Nass, D. Degan, J. Dawson, M. Johnson, B. Olson, and C.H. Arrison. 2006. Assessing Chinook salmon escapement in Mill Creek using acoustic technologies in 2006. U.S. Fish and Wildlife Service, Anadromous Fish Restoration Program, U.S. Department of the Interior.

National Marine Fisheries Service. 2012. Southern California Steelhead Recovery Plan. Southwest Region, Protected Resources Division, Long Beach,California.

Pipal, K.A., J. J. Notch, S.A. Hayes, and P. B. Adams. 2012. Estimating Escapement for a Low-Abundance Steelhead Population Using Dual-Frequency Identification Sonar (DIDSON). North American Journal of Fisheries Management, 32:5, 880-893.

FIGURES

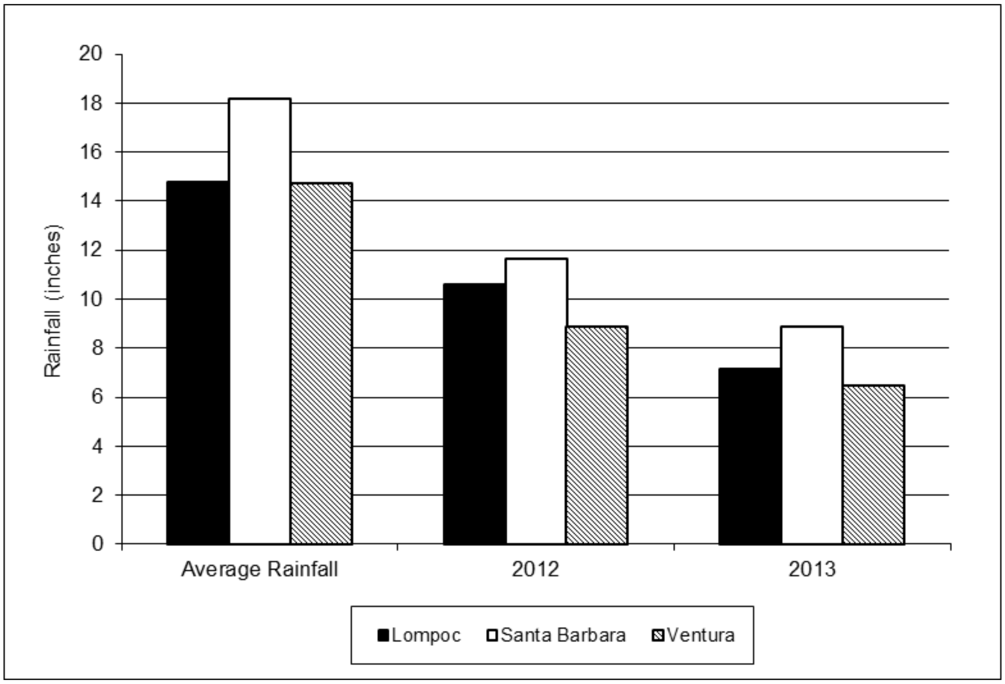


Figure 1: Rainfall amounts for Lompoc, Santa Barbara, and Ventura in 2012 and 2013. Average rainfalls for Santa Barbara and Lompoc, and base rainfall for Ventura are displayed, as well as the rainfall totals for these locations in 2012 and 2013.

Figure 2: Topanga Creek solar trailer (left), DIDSON in low water (right)

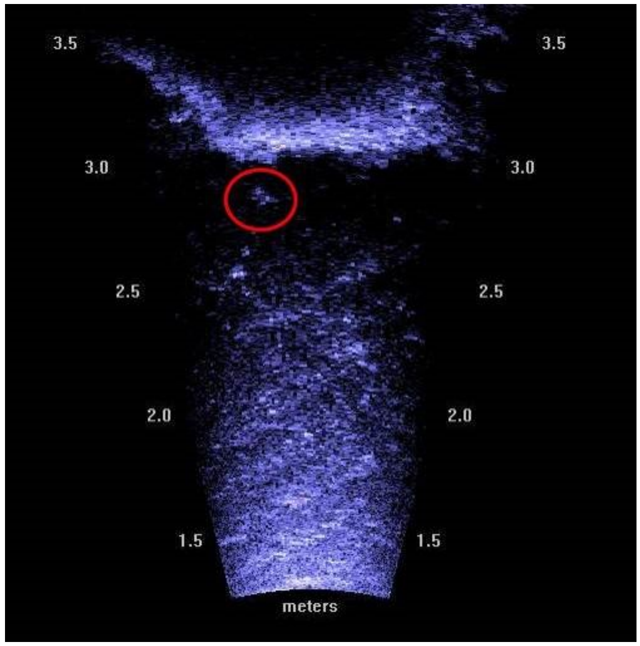
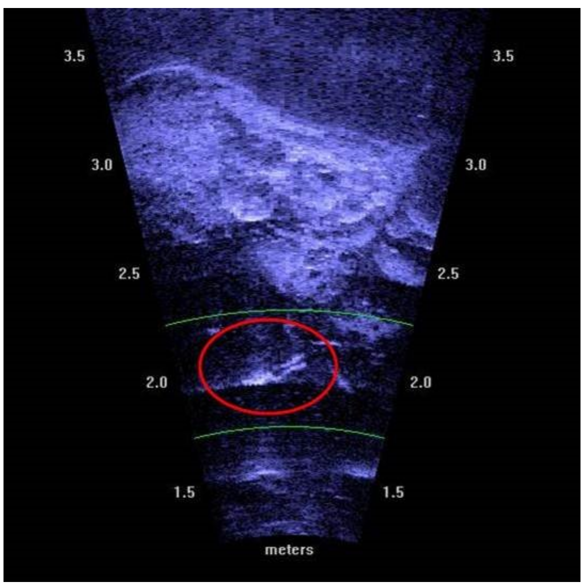


Figure 3: DIDSON image of a chorus frog with its legs extended, from Topanga Creek April 2012 deployment



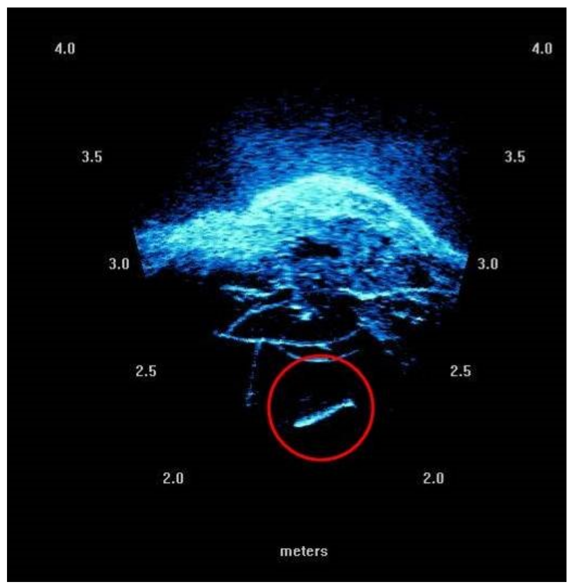


Figure 4: Arroyo Hondo Creek red legged frog (left), *O. mykiss* (right)

Figure 5: Beaver Dams, upstream (left) and downstream (right) of the Salispuedes DIDSON site.

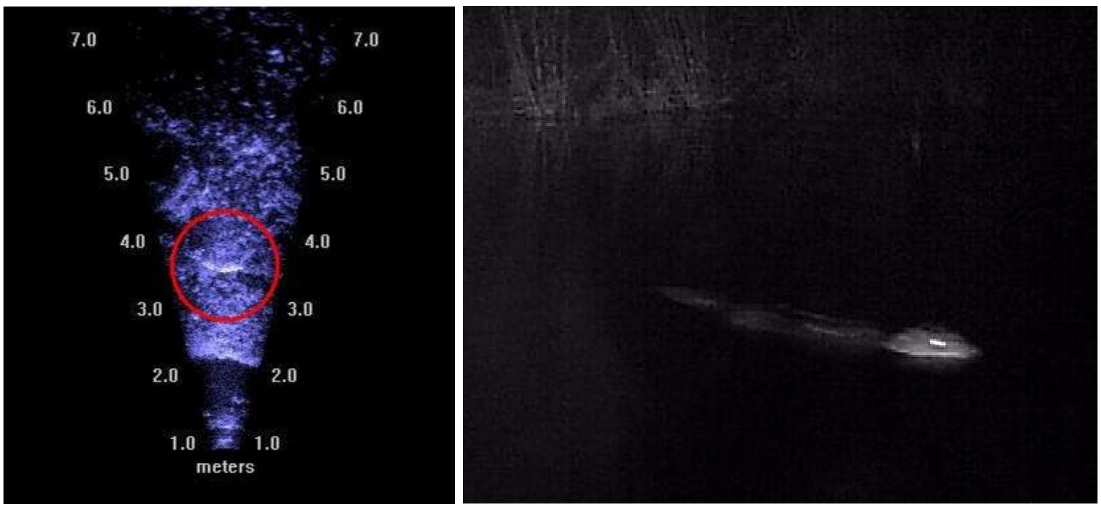


Figure 6: Beaver image from DIDSON (left, circled) and trail camera (right) confirming DIDSON images as beavers.

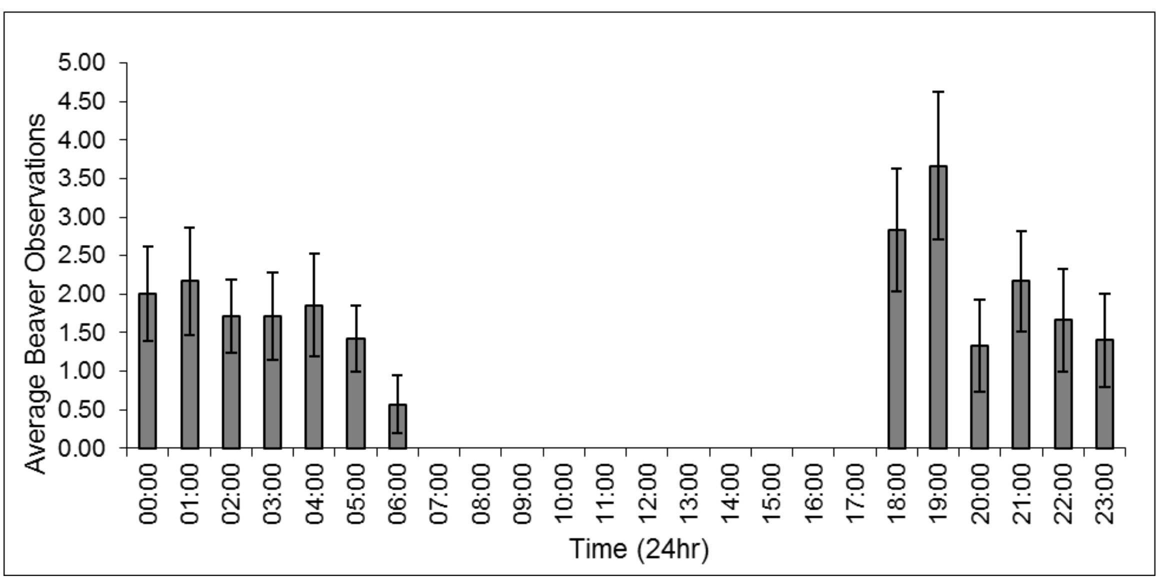


Figure 7: Beaver observations in Salsipuedes Creek. This graph shows the average number of observations for each hour, based on 5-7 days of deployment. Error bars represent +/- 1 standard error.

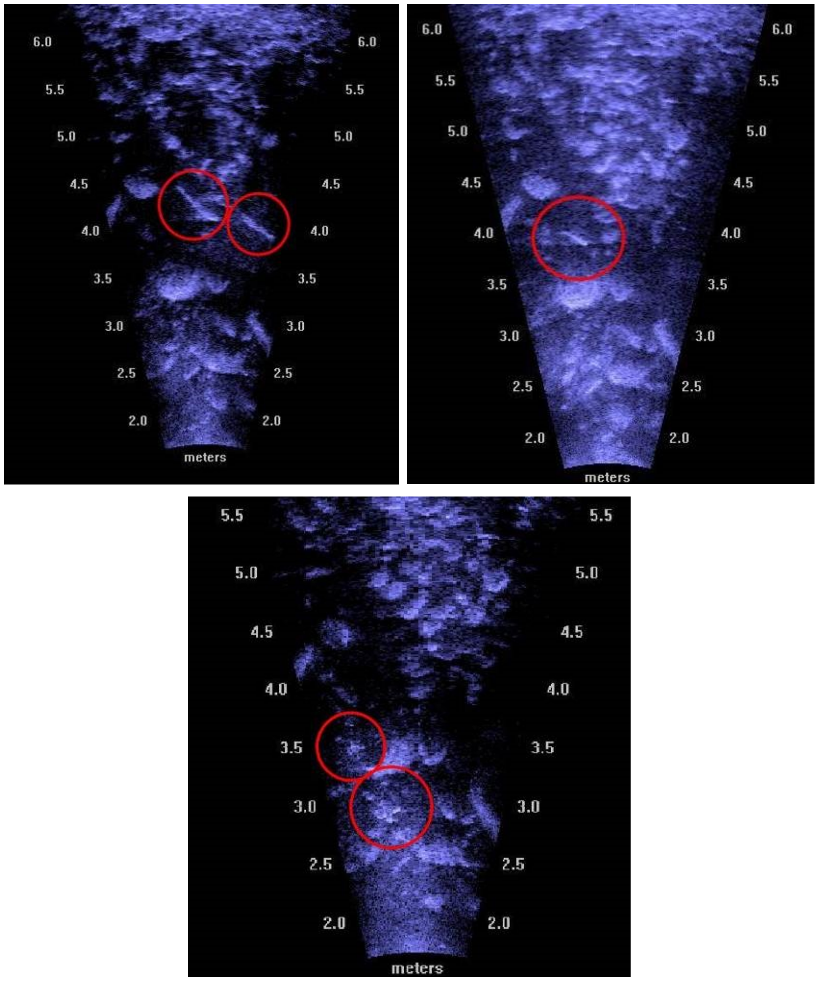


Figure 8: Ventura River, two carp with the one on the right feeding and creating a sediment cloud (top left), *O. mykiss* (top right), and two turtles (bottom).