

# Northwest Science Notes

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Vaughn L. Paragamian<sup>1</sup> and Virginia D. Wakkinen, Idaho Department of Fish and Game, 2750 Kathleen Avenue, Coeur d'Alene, Idaho 83815

## A Comparison of Single and Paired Ultrasonic and Radio Transmitter Retention by Kootenai River White Sturgeon

### Abstract

Ultrasonic and radio telemetry has proven to be a valuable tool in movement and behavior studies of white sturgeon (*Acipenser transmontanus*) in the Pacific northwest. Our objective was to determine if external attachment of paired transmitters (ultrasonic and radio) allowed adequate retention time to satisfy our objective of monitoring adult white sturgeon through a minimum of 120 d during the pre-spawn and spawning season. From 1993 through 2003 we attached ultrasonic transmitters to 34 adult white sturgeon and both ultrasonic and radio transmitters to 108 adult white sturgeon. The mean transmitter availability was 830 d for single and 701 d for paired transmitters. Mean attachment duration was 309 d for single transmitter and 490 d for paired transmitters. Five individuals (14.7%) shed ultrasonic and 33 (30.6%) shed paired ultrasonic and radio transmitters before the end of the life expectancy of the ultrasonic transmitter batteries. We were unable to detect a significant difference in tag retention time between the paired and unpaired tags. Deployment of both ultrasonic and radio transmitter on a white sturgeon did not appear to compromise our studies with most transmitters staying attached for at least 120 d. However, once a tag had been on 0-600 days, single tag deployments performed better. For short term investigations our study suggests managers and researcher of white sturgeon populations can benefit from attaching both transmitters but long term studies should be restricted to deployment of a single transmitter.

### Introduction

Ultrasonic and radio telemetry has become an important tool in movement and behavior studies of a wide range of fish species (Malinin 1971; Paragamian 1989; Eiler 1995; Peake et al. 1997) including Acipenserids (Buckley and Kynard 1985; Fox et al. 2000; Borkholder et al. 2002; Perrin et al. 2003). Ultrasonic and radio transmitters can be attached to fish in a variety of external and internal methods (Winter 1996). Internally placed transmitters may have a longer retention time. But non-invasive external attachment is advantageous in that it requires less time and minimizes the chance of infection and other complications related to surgery. The success of

any telemetry study implementing an external attachment technique depends on several variables of which retention time of the transmitter is second only to the survival of the fish. The transmitter must remain attached throughout the study period or through a critical migration or spawning period. Retention time ultimately may depend on the attachment method (Collins et al. 2002). For large white sturgeon (*Acipenser transmontanus*) in the Pacific Northwest transmitters are commonly mounted externally near the base of the dorsal fin (Haynes et al. 1978; Brannon and Setter 1992; RL&L 2000; Paragamian and Kruse 2001). Collins et al. (2002) studied the short-term (93 d) retention time using three styles of attachment of radio transmitters to shortnose sturgeon (*A. brevirostrum*); two internal methods and attachment of a single external radio transmitter. They found loss of external transmitters began as soon as the second day and by 41 d all but one of 12

<sup>1</sup>Author to whom correspondence should be addressed. Current address: Idaho Department of Fish and Game, 2750 Kathleen Avenue, Coeur d'Alene, Idaho 83815  
E-mail: vparagam@idfg.idaho.gov

transmitters were shed. In studies of white sturgeon in the Kootenai River we have externally attached paired radio and ultrasonic transmitters to adult fish (Paragamian and Kruse 2001; Paragamian et al. 2002). The deployment of both types of transmitters improve our ability to track individual fish by providing the advantages of both types of transmitters. The ultrasonic transmitter enabled us to locate white sturgeon more quickly at greater distances and depths. The radio transmitter, which can be located with aerial surveys and land based fixed location receivers, gave us the opportunity to locate fish in a shorter period of time and facilitated the location of white sturgeon in turbulent waters. Radio transmitters also appeared to give us greater precision in location of fish when we recorded a GPS location. However, using two external transmitters that are connected by the same cable may compromise the study if there is significantly less retention time compared to a single transmitter deployment. Although we had used both deployment methods for a decade (Paragamian and Kruse 2001; Paragamian et al. 2002), attachment retention by the two methods had not been evaluated. Additional studies called for an assessment of the two methods and validation that the attachment of two transmitters did not compromise our studies. In our *a posteriori* study it was also important that the average retention time of a majority of transmitters at least exceed the duration of the pre-spawn and spawning season (about 120 d) in order that behavior and movement of white sturgeon could be documented for this minimum period of time.

## Methods

Adult white sturgeon were captured with rod and reel or set lines from March 1993 through April 2003 (Paragamian and Kruse 2001). White sturgeon caught from February through March each year were primarily adults in a pre-spawn condition. The objective was to capture and attach transmitters to pre-spawn adults and monitor their movements and behavior during the pre-spawn and spawning season (Paragamian and Kruse 2001). Captured white sturgeon were placed into a hooded stretcher and covered with water during data collection and tagging (Paragamian and Kruse 2001). Radio and ultrasonic transmitters were attached to opposite sides of the dorsal fin base by passing stainless steel aircraft cable through two incisions created by sterilized surgical needles.

The ultrasonic transmitter (Sonotronics, Tucson, Arizona Model CT-82-3) was 9.0 cm in length, 1.8 cm in diameter, weighed 8 g, at a frequency of 75 kHz with a 1,440 d life expectancy while the radio transmitter (Advanced Telemetry Systems, Isanti, Minnesota Model F2000) was flat, 1.0 cm thick, 5.0 cm in length, 2.0 cm wide, weighed <70 g, at frequencies of 30-31 kHz, and had a life expectancy of 550 d. For attachment of transmitters one twelve-inch length of cable (about 0.75 mm diameter) was threaded through two holes on the ultrasonic transmitter, the base of the dorsal fin, and two holes on the radio transmitter via the surgical needles. The cable was overlapped on the back of the radio transmitter and secured by crimping aluminum cable sleeves. For the single ultrasonic transmitter attachment a similar method was used except that the cable was threaded through a narrow strand of plastic surgical tubing on the opposite side first. The plastic tubing was to keep the cable from binding on the flesh of the fish. In general, because adult white sturgeon are large, the 2% weight to transmitter ratio recommendation did not apply (Winter 1996).

We examined the retention time and transmitter availability to tracking of two transmitter deployment methods on adult white sturgeon: single ultrasonic transmitter attachment and attachment of an ultrasonic paired with a radio transmitter. In our study, we further defined tag retention (or duration) to assume transmitter availability to tracking before shedding. Tag retention time therefore referred to the time that a transmitter was on a fish before being shed and the fish was locatable. Transmitter availability to tracking with respect to transmitters that were not shed implied that they remained in the study area and were locatable. Transmitter availability ceased when fish moved to areas of the Kootenai River or Kootenay Lake that inhibited telemetry or that were not sampled as frequently. As a result, the fish may not have been located again, even though its tag (or tags) was still attached and functioning.

A transmitter or transmitters were considered shed if there were multiple contacts over a period of 10 d at the same location or a fish was recaptured and the transmitters were absent. In some circumstances SCUBA divers were able to retrieve shed ultrasonic transmitters with the aid of an underwater ultrasonic receiving device. We used Welch's two-sample t-test (Snedecor and Cochran 1989) to compare attachment retention

because the sample sizes were unequal. The objective was to test the mean transmitter availability to tracking of single versus paired tags, for all tags combined, and again for mean transmitter attachment duration for shed tags only. We also used logistic regression analysis of tag shedding with tag deployment method (single versus paired transmitters) and then again with both tag deployment method and time from deployment to estimate the probability of shedding of transmitters and if transmitter attachment success was influenced by the method (Analytical Software 1998; White and Garrott 1990).

## Results and Discussion

We attached ultrasonic and both ultrasonic and radio transmitters to a total of 142 white sturgeon from 1993 through 2003. Sturgeon ranged in length from 122 to 307 cm TL (105-276 cm FL) and weights of 9.1 to 159.1 kg and averaged 193 cm TL (170 cm FL) and 42.9 kg. Of these 142 tagged sturgeon, 34 individuals had only ultrasonic and 108 had both ultrasonic and radio transmitters attached. Of this unequal sample, five fish (14.7%) shed ultrasonic and 33 individuals (30.6%) shed paired transmitters (Table 1). The longest a white sturgeon was tracked before the fish was unavailable to tracking or both transmitters had expired was 2,456 d. From 0-120 d, two (5.9%) of the 34 ultrasonic transmitters and seven (6.5%) of the 108 ultrasonic and radio transmitters were shed. During the next 120 days, a total of three of the single and 11 of the paired transmitters were shed. Average transmitter attachment

time for over 70% of the transmitters extended beyond the minimum acceptable time period of 120 d using either method (Table 1).

Mean retention for a single ultrasonic transmitter was 309.0 days (SD = 326.9) while paired tag retention was 489.5 days (SD = 436.0) (Table 1). We did not detect a difference in the means using Welch's two-sample t-test ( $P = 0.853$ ). Standard deviations were quite large due to the great variation in tag retention (from 3 d to 823 d for single transmitters and 26 d to 1,976 d for paired). We also examined mean availability to tracking of single and paired tags for the full dataset (N=142 deployed tags). Tag availability ranged from 3-1,698 days for single and 1-2,456 days for paired tags. The mean number of days of availability was 830.3 (SD=396.6) for single and 701.4 days (SD=503.5) for paired transmitters. Again, we did not detect a difference in the means (Welch's two-sample t-test,  $P = 0.125$ ).

Collins et al. (2002) success with the external attachment method of transmitters was far less than ours. Collins et al. (2002) reported shortnose sturgeon with an external attachment were frequently observed intentionally rubbing the transmitters against rocks placed in their study tanks to replicate wild conditions. White sturgeon in the Kootenai River may not have attempted to rub transmitters off. We expect had they done so transmitter retention would have been far less because Collins et al. (2002) explained transmitters were lost because cables frayed and then broke. However, an unmeasured variable in our study and Collins et al. (2002) was possible

TABLE 1. Transmitter duration, percent transmitter shed and percent available to tracking for two methods of transmitter attachment.

Transmitter attachment method	Total number transmitter	Percent transmitter shed	Percent to tracking 0-120 days	Percent to tracking 0-600 days	Percent available to tracking 0-1,440 days (warranted life of transmitter)	Mean (SD) transmitter duration (days) non-shed transmitter	Mean (SD) transmitter duration (days) shed transmitter only
Ultrasonic	34	14.7%	94.1%	87.9%	37.5%	956.2 (291.2) N=29	309.0 (326.9) N=5
Paired ultrasonic and radio	108	30.6%	93.0%	69.1%	23.8%	780.4 (510.8) N=75	489.5 (436.0) N=33

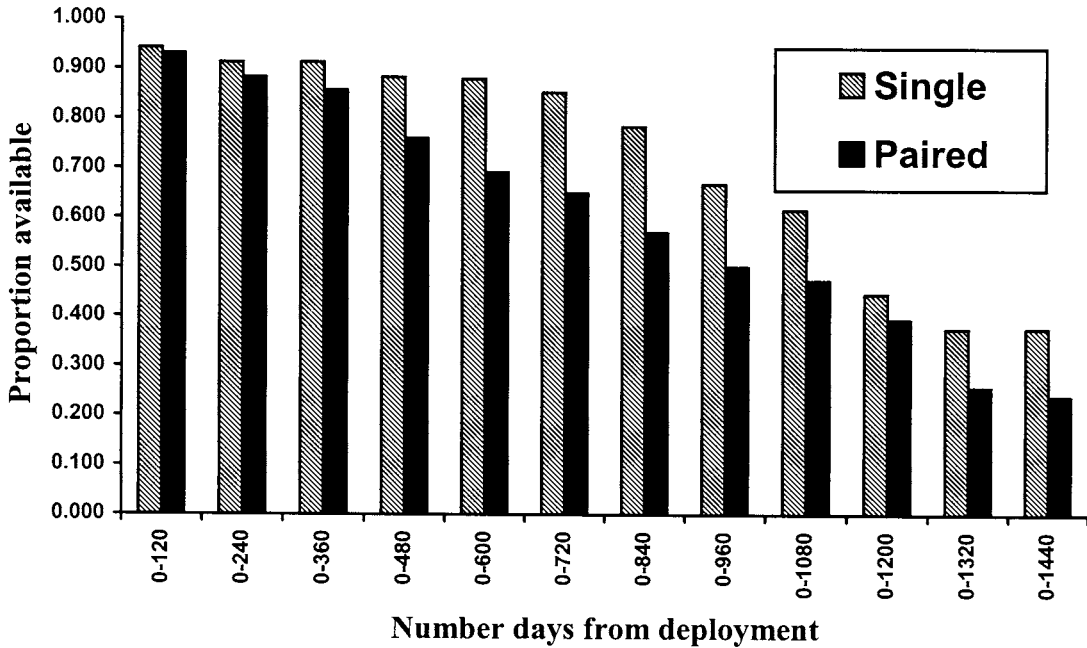


Figure 1. Proportion of paired versus single deployed tags available to tracking by time (days) from deployment.

attachment error by the individual fastening the transmitters.

We also tested the model that the odds of transmitter shedding are influenced by transmitter deployment method (single vs. paired transmitter). Tag deployment method appeared to influence the probability of tag shed ( $P=0.057$ ) when looking at all deployed tags ( $N=142$ ). Five fish (14.7%) shed ultrasonic and 33 (30.6%) shed paired transmitters before the last day a tag was available to tracking. We suspected that the variability in the time tags were available to tracking (1 to 2,456 d) might be confounding any effect of tag deployment method. We ran the logistic regression of tag shed again, including time from deployment (12 cumulative 120-d categories) along with tag deployment in the model. Tag deployment method and time from deployment strongly influenced tag shedding ( $P<0.001$ ). The analysis of deviance table indicated that both variables were important to the model. There were 94.1% of the single and 93% of the paired tags available to tracking from 0-120 days after deployment (Figure 1). By 0-600 days, there were 87.9% of the single and only 69.1% of the paired

transmitters still available. The model correctly classified more than 80% of the cases and reduced the error of classification of cases as shed or not shed by more than 60% ( $\text{tau-}P=0.603$ ). Logistic regression of the cumulative 120-day categories independently further suggested that time from deployment (days) influenced tag shedding once tags had been on 0-600 days ( $P=0.015$ ).

The logistic regression analysis supported our earlier conclusion that deployment of both ultrasonic and radio transmitters does not compromise tag retention time within the first 0-120 days of deployment, our initial objective. Pairing tags may have benefited our telemetry studies by giving us a longer opportunity to locate white sturgeon by water, with land based fixed location radio receivers, and with aerial surveys. However, once a tag had been on 0-600 days, single tag deployments performed better. For short term investigations our study suggests managers and researcher of white sturgeon populations can successfully gain benefits of both transmitters on individual fish but long term studies should be restricted to deployment of a single transmitter.

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