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Seasonal Movements of White Sturgeon (*Acipenser transmontanus*) in the Mid-Columbia River

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ABSTRACT

Twenty-nine white sturgeon (*Acipenser transmontanus*) were instrumented in 1975 and 1976 with separately identifiable radio transmitters to study seasonal movements in the mid-Columbia River, southeastern Washington. Tagged fish remained in free-flowing areas of the river and were inactive in winter. Movements occurred in summer and early fall. Activity appeared related to water temperature and sturgeon size.

There is considerable confusion concerning movement patterns of white sturgeon (*Acipenser transmontanus*). Early workers considered it anadromous (Jordan and Evermann 1908; Craig and Hacker 1940). Although some individuals can be found in the ocean and ascend rivers to spawn, others remain in fresh water throughout life. Those found in the upper Columbia River and its tributaries are landlocked by a system of hydroelectric dams.

Movements of white sturgeon have been studied in the lower Columbia River (Bajkov 1949, 1951). However, no information exists on sturgeon activity patterns in the mid-Columbia region. We used radio telemetry to evaluate white sturgeon movements between Priest Rapids and McNary dams (Fig. 1) from June 1975 through October 1976. This section remains free-flowing and may be vital for sustained white sturgeon survival in the mid-Columbia River.

METHODS

Radio telemetry equipment was designed and built by the Bioelectronics Laboratory, University of Minnesota (Tester and Siniff 1976). Receivers operated on a carrier frequency of 53 MHz and were capable of distinguishing 100 discrete crystal-tuned transmitters. Transmitters were encased in epoxy, which also anchored teflon-coated attachment cables, and ranged from 1.8 to 4.4 cm in diameter, 6.3 to 10.0 cm in length, and 15 to 70 g weight in water. Transmitters were selected in the field so in water weight did not exceed 2% of estimated sturgeon body weight. Transmitter life depended on battery size and ranged from 120 to 800 days. Range depended mainly on transmitter depth and, to a lesser extent, on transmitter antenna orientation to the receiving antenna. Transmitter range averaged 1.5–3.0 km at the water surface and 0.3–0.8 km at 15 m depth.

Sturgeon were collected during June, August, and October 1975 and July 1976, in the Hanford Reach of the Columbia River, at White Bluffs pool and below Ringold (Fig. 1) by trammel net, rod and reel, and trotlines. After capture and until tagging, large sturgeon were held in the river by a rope looped around the tail, while smaller sturgeon were placed into a holding net. Fish were calmed by a wet towel wrapped around the head and eyes and held underwater during tagging.

Attachment instruments and cables were sterilized in alcohol before use. A surgical cutting needle was used to insert cables through the fatty tissue along the dorsum and beneath the dorsal spine ridge. Cables were passed through small plastic plates on each side of the fish. The transmitter was firmly buttressed against one plate and cables were tied against the opposing plate. (Fig. 2). Prior to release total fish lengths were measured with a steel tape and surgical incisions and capture-caused abrasions were treated with malachite green to retard infection.

After release, sturgeon were monitored

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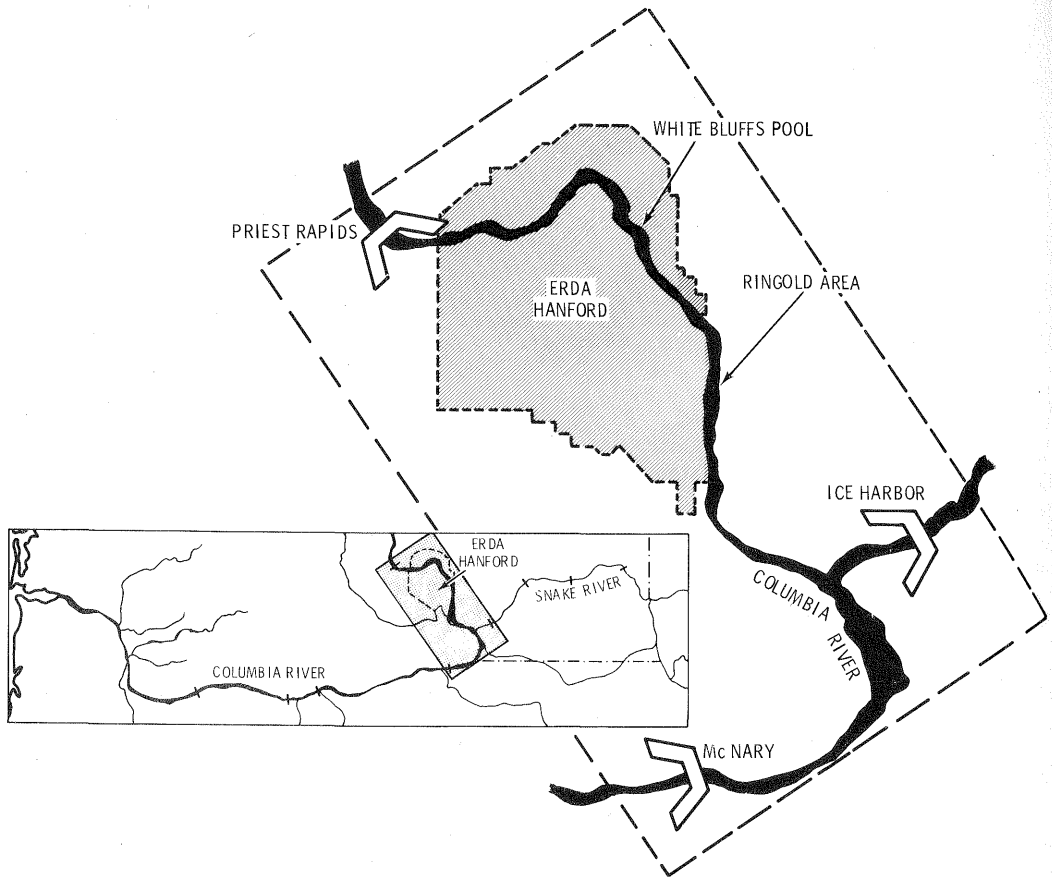

FIGURE 1.—*The mid-Columbia River study area for white sturgeon movements.*

using boat- and truck-mounted antennas, and located once or twice per week during periods of active movement. Fish positions were recorded on river maps. Occasional depth soundings were made after a fish was located. In July 1976 an automatic receiving station with stripchart recorder (Rustrack Model 288)[2] was established at White Bluffs pool and provided continuous information on sturgeon presence in or absence from the pool. However, the unit could not differentiate between upstream and downstream movement.

River temperatures were recorded at Priest Rapids Dam and in the White Bluffs Pool and Ringold areas. Total and net movement distances were determined for all fish. Total distance was the sum of the absolute values of the differences in kilometers between successive sighting locations. Net distance was the actual displacement from point of release to final location at the end of the study or transmitter life.

RESULTS AND DISCUSSION

No mortalities occurred during or immediately after tagging. Released fish appeared to swim normally with no evidence of listing or difficulty in movement. Twenty-six of 29 radio transmitters operated long enough to yield movement information. Although some sturgeon moved great distances, others remained near release locations.

Twelve (46%) of 26 sturgeon moved more than 0.8 km from their release points. White Bluffs pool is about 1.6 km long and move-

[2] Mention of trade names does not imply endorsement by Battelle.

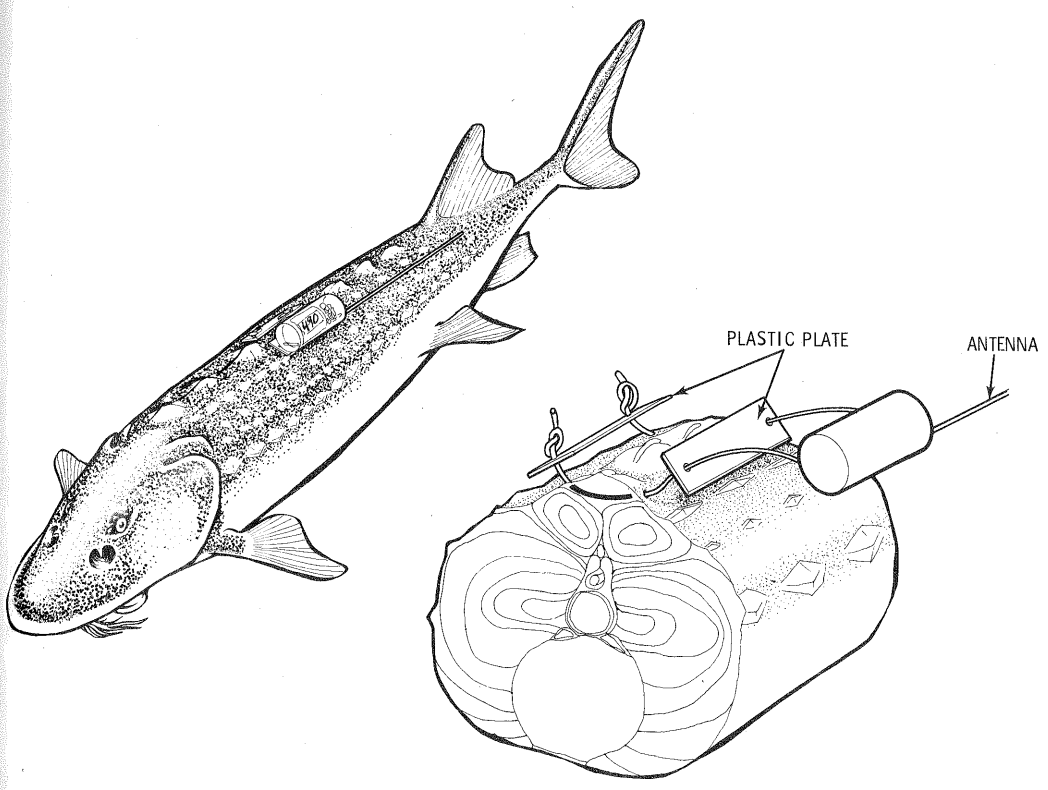

FIGURE 2.—*White sturgeon, showing attachment of radio transmitter.*

ment greater than 0.8 km from midpool was considered to indicate travel outside the pool. Fourteen (54%) sturgeon monitored from 3 to 18 months remained within ±0.8 km of their release points. Mean total distance moved for tagged fish not moving more than 0.8 km from release points was 0.4 km. Sturgeon that moved more than 0.8 km from release points averaged a total distance traveled of 40.2 km.

Tagged fish that displayed a net downstream movement averaged 87 cm total length and those that remained near the release location averaged 131 cm. Fish that moved upstream only, or those whose transmitters failed after a net upstream displacement, averaged 176 cm. Sheffe's test following a one-way analysis of variance of $\log_e$ transformed lengths (Eberhardt 1968) showed significant differences ($P < 0.05$) in sizes among fish moving in different directions. Hartley's test showed that $\log_e$ transformation was necessary to stabilize the variances of the data (Snedecor and Cockran 1972).

Movements from release locations began in mid-June, 1975 and 1976, when water surface temperatures ranged from 13.0 to 14.0 C (Table 1). Movements ceased in mid-October when water temperatures were about 15 C. In all cases sturgeon did not move more than 0.2 km from November through May, a period which appeared to be a dormant season. With the exception of two fish that moved far downstream, temperature recording locations bracketed the area containing tagged fish. Differences between surface water temperatures at Priest Rapids Dam and Richland were about 1 C. Since the Columbia River is well mixed in this area (Page et al. 1976; Gray et al. 1976), bottom temperatures where sturgeon reside were the same as surface temperatures.

Our data indicate sturgeon are capable of long distance travel over short periods. Upstream moving fish generally moved 3–12

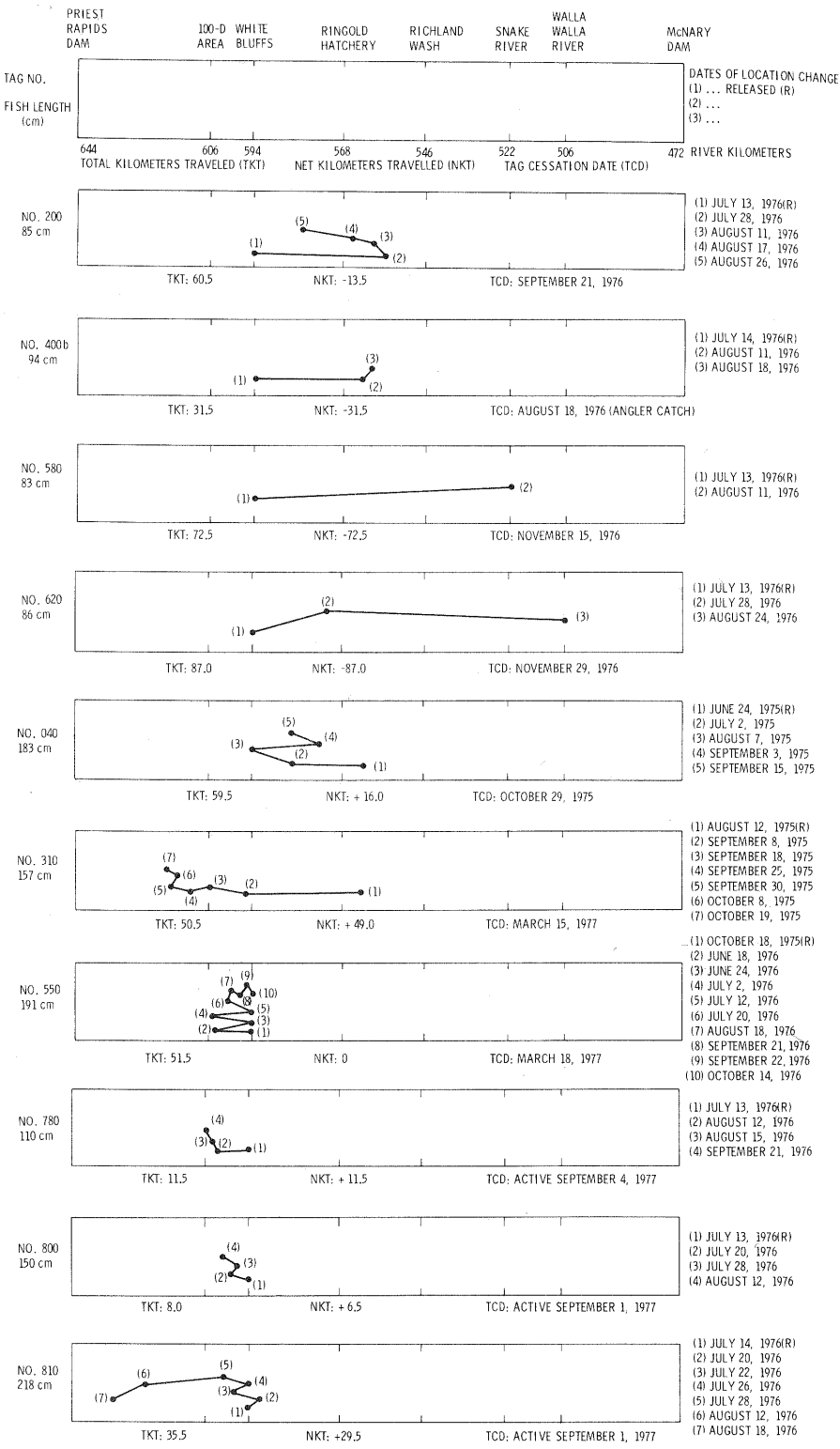
PRIEST RAPIDS DAM
100-D AREA
WHITE BLUFFS
RINGOLD HATCHERY
RICHLAND WASH
SNAKE RIVER
WALLA WALLA RIVER
McNARY DAM
TAG NO.
FISH LENGTH (cm)
DATES OF LOCATION CHANGE
(1) ... RELEASED (R)
(2) ...
(3) ...
644
606
594
568
546
522
506
472 RIVER KILOMETERS
TOTAL KILOMETERS TRAVELED (TKT)
NET KILOMETERS TRAVELLED (NKT)
TAG CESSATION DATE (TCD)
NO. 200
85 cm
(1) JULY 13, 1976(R)
(2) JULY 28, 1976
(3) AUGUST 11, 1976
(4) AUGUST 17, 1976
(5) AUGUST 26, 1976
TKT: 60.5
NKT: -13.5
TCD: SEPTEMBER 21, 1976
NO. 400b
94 cm
(1) JULY 14, 1976(R)
(2) AUGUST 11, 1976
(3) AUGUST 18, 1976
TKT: 31.5
NKT: -31.5
TCD: AUGUST 18, 1976 (ANGLER CATCH)
NO. 580
83 cm
(1) JULY 13, 1976(R)
(2) AUGUST 11, 1976
TKT: 72.5
NKT: -72.5
TCD: NOVEMBER 15, 1976
NO. 620
86 cm
(1) JULY 13, 1976(R)
(2) JULY 28, 1976
(3) AUGUST 24, 1976
TKT: 87.0
NKT: -87.0
TCD: NOVEMBER 29, 1976
NO. 040
183 cm
(1) JUNE 24, 1975(R)
(2) JULY 2, 1975
(3) AUGUST 7, 1975
(4) SEPTEMBER 3, 1975
(5) SEPTEMBER 15, 1975
TKT: 59.5
NKT: + 16.0
TCD: OCTOBER 29, 1975
NO. 310
157 cm
(1) AUGUST 12, 1975(R)
(2) SEPTEMBER 8, 1975
(3) SEPTEMBER 18, 1975
(4) SEPTEMBER 25, 1975
(5) SEPTEMBER 30, 1975
(6) OCTOBER 8, 1975
(7) OCTOBER 19, 1975
TKT: 50.5
NKT: + 49.0
TCD: MARCH 15, 1977
NO. 550
191 cm
(1) OCTOBER 18, 1975(R)
(2) JUNE 18, 1976
(3) JUNE 24, 1976
(4) JULY 2, 1976
(5) JULY 12, 1976
(6) JULY 20, 1976
(7) AUGUST 18, 1976
(8) SEPTEMBER 21, 1976
(9) SEPTEMBER 22, 1976
(10) OCTOBER 14, 1976
TKT: 51.5
NKT: 0
TCD: MARCH 18, 1977
NO. 780
110 cm
(1) JULY 13, 1976(R)
(2) AUGUST 12, 1976
(3) AUGUST 15, 1976
(4) SEPTEMBER 21, 1976
TKT: 11.5
NKT: + 11.5
TCD: ACTIVE SEPTEMBER 4, 1977
NO. 800
150 cm
(1) JULY 13, 1976(R)
(2) JULY 20, 1976
(3) JULY 28, 1976
(4) AUGUST 12, 1976
TKT: 8.0
NKT: + 6.5
TCD: ACTIVE SEPTEMBER 1, 1977
NO. 810
218 cm
(1) JULY 14, 1976(R)
(2) JULY 20, 1976
(3) JULY 22, 1976
(4) JULY 26, 1976
(5) JULY 28, 1976
(6) AUGUST 12, 1976
(7) AUGUST 18, 1976
TKT: 35.5
NKT: +29.5
TCD: ACTIVE SEPTEMBER 1, 1977

TABLE 1.—*Average weekly water temperatures during tagged white sturgeon (*Acipenser transmontanus*) movements in the Hanford reach of the Columbia River.*

1975		1976	
Date	Temperature (C)	Date	Temperature (C)
June 21–27	13.6	June 13–19	13.0
June 28–July 4	13.6	June 27–July 3	13.7
August 2–8	16.4	July 11–17	15.0
August 9–15	16.6	July 18–24	16.1
August 30–September 6	16.8	July 25–31	17.2
September 7–13	17.8	August 8–14	17.9
September 14–20	17.7	August 15–21	17.8
September 21–27	17.5	August 22–28	17.8
September 28–October 24	16.4	September 12–18	16.4
October 5–11	15.4	September 19–25	17.0
October 12–18	14.6	October 10–16	15.2

km per week (Fig. 3) while downstream moving fish generally moved 16 or more km in a week. One fish moved 10 km upstream and back three times (Fig. 3: No. 550) between June and October 1976, before returning to the original site for a second winter. Another, not included in Figure 3, engaged in the same pattern over shorter distances.

Several fish moved sizable distances after spending winter and spring within ±0.8 km of release points. One sturgeon, caught by an angler 34 days after release, moved 31.2 km downstream (Fig. 3: No. 400b). Only three radio-tagged sturgeon moved from the free-flowing region of the Columbia River into the McNary Dam reservoir. One fish returned upstream shortly after entering the upper reaches of the reservoir (Fig. 3: No. 200). Two other fish moved to the mouths of the Snake and Walla Walla rivers, where they remained until transmitter failure in November 1976 (Fig. 3: Nos. 580 and 620). Our data tend to support Bajkov's (1951) assertion that sturgeon prefer free-flowing habitats. Free-flowing water may be necessary for successful sturgeon spawning (Scott and Crossman 1973).

Additionally, our data agree with Bajkov (1949, 1951) and Scott and Crossman (1973) concerning sturgeon seasonal depth locations. Radio signals were stronger in summer and weaker in winter. These findings, combined with position fixes, suggested fish were shallower during periods of maximum activity in summer and deeper during periods of minimum activity in winter. Two sturgeon spent much of summer 1976 in or near the shallow White Bluffs slough and reentered White Bluffs pool, with a depth of 16 m, in fall.

Bajkov (1951) and Scott and Crossman (1973) suggested juvenile white sturgeon moved upstream in late summer and fall to exploit dying salmon runs and moved downstream in spring and early summer to exploit smelt runs in Pacific coastal rivers. Although the White Bluffs section of the Columbia River is a major salmon spawning area (Watson 1970), smelt do not occur (Gray and Dauble 1977). In lower Pacific coastal rivers, mature adults were thought (Scott and Crossman 1973) to move upstream from May through July to spawn and move downstream again in late summer and fall. Movement of larger sturgeon upstream and smaller sturgeon downstream has also been noted in the Snake River (J. Coon, pers. comm.). Eight of our tagged adult fish moved upstream in late spring and early summer. Two of these moved downstream in late summer and early fall and returned to areas of initial release. The other six fish remained upstream in deep, swift current areas, similar to White Bluffs pool (Fig. 3).

It is not known why the smallest sturgeon

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FIGURE 3.—*Schematic diagrams of the Columbia River study area, showing movement patterns of individual white sturgeon. Net upstream movements are indicated by +, net downstream movements by −. Fish sizes are total length.*

moved downstream in summer, larger sturgeon moved upstream in summer and fall, and intermediate sized sturgeon remained near release points. Similarities exist between these behavior patterns and those found in the lower Columbia River. Perhaps recently landlocked populations have retained adaptive behavior patterns from free-flowing situations. If white sturgeon prefer or require free-flowing habitat, extensive impoundment of the Columbia and Snake rivers and resultant habitat reduction could be detrimental to population survival.

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