University of South Alabama Ichthyological Collection (USA·C 6278). Measurements and weights are found in Table 1.

Since most records of *C. isodon* are of juveniles, there is little information on the reproductive biology of the species. Based on the cited literature and these data, pups appear to be 45-55 cm at birth. However, seasonality is uncertain as the records of Springer (1950) are not in accord with those of either Hoese and Moore (1977) or this report.

Length at maturity can be closely estimated. One male (112 cm) collected 13 July 1978 was immature—based on incomplete calcification of the claspers and incompletely developed siphon sacs, each sac being 7.5 cm long and 1.0 cm wide. The other two males (120 and 127 cm) collected 2 July 1979 and 28 June 1978 had well-calcified claspers and fully developed siphon sacs. The only literature on mature males (Springer 1950) listed lengths of 140-152 cm. Males apparently mature between 115 and 120 cm. Maturity in females must be reached at a larger size. The female collected in July 1979 was 127 cm, yet was immature with only small undeveloped ovarian eggs. The gravid female reported here was 139 cm, and those reported by Springer (1950) were 147-155 cm.

Carcharhinus isodon was only collected when similarly sized specimens of blacktip shark, *C. limbatus*, were caught: 3 *C. limbatus* (126-166 cm) with the gravid female, 12 *C. limbatus* (102-117 cm) with the 112 cm male, 2 *C. limbatus* (111 and 124 cm) with the 127 cm male, and 12 *C. limbatus* (100-130 cm) with the two specimens caught in 1979. If *C. isodon* is an uncommon straggler into the northern Gulf of Mexico it may be schooling with other sharks of like size. Sharks that school have been noted to do so by sex or size (Ford 1921).

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STEVEN BRANSTETTER
ROBERT L. SHIPP

University of South Alabama
Dauphin Island Sea Lab
P.O. Box 386
Dauphin Island, AL 36528

SHEDDING RATES OF PLASTIC AND METAL DART TAGS FROM ATLANTIC BLUEFIN TUNA, *THUNNUS THYNNUS*[1]

In 1971, the International Commission for the Conservation of Atlantic Tunas (ICCAT) recommended that a double-tagging experiment be conducted on Atlantic bluefin tuna, *Thunnus thynnus*, to determine whether plastic or metal dart tags were more efficient and to estimate immediate and instantaneous tag shedding rates. A knowledge of shedding rates is necessary so that appropriate adjustments can be made when estimating mortality rates from tag return data. This study was begun in 1971 by the National Marine Fisheries Service (NMFS), the Woods Hole Oceanographic Institution (WHOI), and the Fisheries Research Board of Canada (FRBC). The

[1]Southeast Fisheries Center Contribution Number 80-14M.

results obtained through 1972, for 580 double-tagged bluefin tuna released during 1971 off the east coast of the United States, were reported by Lenarz et al. (1973). Their results were partially based on tags supplied by the FRBC, some of which had longer streamers than the tags supplied by WHOI. For our present analysis, we used only data from the WHOI tags.

In this paper we present the overall findings obtained through 1978 for 3,121 double-tagged bluefin tuna. These fish were released primarily from U.S. purse seine vessels fishing off the east coast of the United States from Virginia to Massachusetts from 1971 through 1977.

Methods

The U.S. double-tagging program for Atlantic bluefin tuna was conducted jointly by the NMFS and WHOI. Tags and tagging procedures were those described by the Food and Agriculture Organization (1972). All fish were tagged and released from U.S. purse seine vessels (98% of all releases) and from a few sport fishing vessels. Tagging occurred throughout the purse seine fishing season during 1971, 1973, and 1974, and at the end of the season during 1972, 1975, 1976, and 1977. The double-tagging operation was conducted entirely by John Mason during each year except 1974, when two assistants aided in the double tagging. Precise release dates were available for all of the fish. In a few instances only the month and year were known for the recapture data. In these cases, the 15th of the month was arbitrarily selected to represent the recapture date. The vast majority of returns fall into an annual cycle during which the recapture periods are approximately 2-3 summer months. The interval midpoints of the time intervals can be considered to be on a yearly cycle. Therefore, we grouped returns into "first year returns," "second year returns," etc., and calculated average days out from the individual days out for each return. Tag shedding rates were estimated using the notation and methodology of Bayliff and Mobrand (1972) for yellowfin tuna, which Lenarz et al. (1973) used for bluefin tuna and Laurs et al. (1976) used for North Pacific albacore. Chapman et al. (1965) developed the original model with the assumption of only one type of shedding which occurs at a constant instantaneous rate. Bayliff and Mobrand (1972) assumed that there are two types, Type I which occurs immediately after the fish are released and Type II, the type described by Chapman et al. (1965).

Bayliff and Mobrand's modifications[2] of the Chapman et al. (1965) approximate equations for tag returns of double-tagged fish are:

$$n_{ddk} = F\tau N_D\, \pi\rho^2 \exp-(F+X+2L)t_k \qquad (1)$$

$$n_{dsk} = 2F\tau N_D\, \pi\rho(1-\rho\exp(-Lt_k)) \exp(-(F+X+L)t_k) \qquad (2)$$

where n_{ddk} = number of returns of double-tagged fish retaining both tags caught during the recapture period t_k,

n_{dsk} = number of returns of double-tagged fish retaining only one tag caught during the period t_k,

F = instantaneous rate of fishing mortality,

N_D = number of double-tagged fish released,

π = proportion of tagged fish which remain alive after the Type-I mortality (immediate) has taken place,

ρ = proportion of the tags which are retained after Type-I shedding (immediate) has taken place,

X = instantaneous rate of mortality due to natural causes, Type-II tagging mortality (long term), and emigration from the fishing grounds,

L = instantaneous rate of tag shedding (Type II), and

t_k = time at the middle of the kth recapture period of length τ (k = 1, 2, 3).

From Equations (1) and (2) it follows that

$$\frac{n_{dsk}}{n_{ddk}} = \frac{2(1-\rho\exp(-Lt_k))\exp(Lt_k)}{\rho}$$

and therefore

$$\frac{n_{dsk}}{2n_{ddk}} = \frac{\exp(Lt_k)-\rho}{\rho} = \frac{\exp(Lt_k)}{\rho} - \frac{2n_{ddk}}{2n_{ddk}}.$$

Rearranging terms yields

[2]As pointed out by Laurs et al. (1976), there was typographical error in both Bayliff and Mobrand (1972) and Lenarz et al. (1973) in Equation (2).

$$\frac{2n_{ddk}}{n_{dsk} + 2n_{ddk}} = \rho \exp(-Lt_k)$$

and hence

$$\ln \frac{2n_{ddk}}{n_{dsk} + 2n_{ddk}} = \ln\rho - Lt_k = Y_k$$

where Y_k is an estimate of the natural logarithm of the proportion of tags retained up to time t_k. Given n_{ddk}, n_{dsk}, and t_k, then L and ρ can be estimated using linear regression. We first estimated these parameters using the usual least-squares linear regression which assumes homoscedasticity. We also believed that it would be appropriate to consider that variability may increase as a function of time as the number of recoveries decreases. To accomplish this, a weighting factor was introduced and a weighted least-squares linear regression model was fitted to calculate values of $\ln\hat{\rho}$ and $\hat{L}$, as was done by Bayliff and Mobrand (1972). The weights for each time interval k ($k = 1, 2, 3$) were equated to the ratio of the number of returns of double-tagged fish during interval k to the total number of returns of double-tagged fish during all k-periods. This can be simply expressed as:

$$\omega_k = \frac{n_{ddk} + n_{dsk}}{\sum_{i=1}^{3} (n_{ddi} + n_{dsi})}.$$

While we consider this a reasonable first approximation of the correct weight, further investigations of the statistical properties of Y_k to formally determine the correct weighting procedure are desirable. Estimates of $\ln\rho$ and L were then made using weighted linear regression.

Results and Discussion

The double-tag releases during 1971 through 1977 and returns in 1971 through 1978 are shown by tag type (Table 1). A sufficient number of tag returns existed to allow examination of three separate recapture periods. Only a few returns existed from beyond the third recapture period. There were approximately equal numbers of each tag type released each year. Table 1 constitutes the basic data used throughout this study. Using the basic data, we estimated values of immediate (Type I) and instantaneous (Type II) shedding rates for each tag type. Further, we tested several hypotheses including: 1) equality of return rates for same year recaptures; 2) equality of return rates by estimated age; and 3) differences in returns and nonreturns over 2 or 3 yr time periods for various time intervals.

Using the double-tagging release data for all years combined (1971-77) the return rate for plastic tags was 5.1% the first year, 8.6% the second year, and 1.6% the third year. The return rate for metal dart tags was 5.5% the first year, 9.1% the second year, and 2.9% the third year. Therefore, for both types of tags the return rates increased the second year and decreased the third year. This should be expected since tagging occurred at the end of the purse seine season for several of the release years studied. Chi-square tests (not cor-

TABLE 1.—Tag releases and returns from northwestern Atlantic bluefin tuna double-tag study. For each of $k = 1, 2,$ or 3 recapture periods the number of returns of double-tagged fish retaining both tags is n_{ddk} and those retaining only one tags is n_{dsk}. The average number of days-at-large for each period is t_k.

	Double-tagged releases		First-year returns			Second-year returns			Third-year returns		
Tag type	Year	Number	n_{dd1}	n_{ds1}	t_1 (days)	n_{dd2}	n_{ds2}	t_2 (days)	n_{dd3}	n_{ds3}	t_3 (days)
Plastic dart (D-tag)	1971	150	4	0	7.25	20	9	349.07	3	1	724.00
	1972	75	6	0	12.83	17	4	340.52	1	1	726.50
	1973	134	18	2	18.45	6	4	354.20	0	1	708.00
	1974	629	25	4	12.07	18	12	352.17	4	7	727.82
	1975	50	0	1	40.00	1	1	384.50	0	0	0
	1976	267	12	2	16.36	2	2	341.00	1	2	707.33
	1977	223	3	1	47.50	25	4	361.83	—	—	—
	Total	1,528	68	10	16.46	89	36	352.06	9	12	723.10
Metal dart (H-tag)	1971	162	4	1	18.60	10	9	358.63	2	3	724.80
	1972	77	0	1	11.00	9	11	343.55	0	1	740.00
	1973	131	12	5	16.88	1	3	373.25	0	2	720.00
	1974	666	28	2	10.97	40	13	358.57	15	11	703.19
	1975	58	1	0	43.00	4	5	339.11	2	0	687.50
	1976	271	23	3	23.08	6	0	311.00	0	4	759.25
	1977	228	8	0	36.00	24	2	365.19	—	—	—
	Total	1,593	76	12	18.76	94	43	354.71	19	21	712.48
	Grand total	3,121	144	22	17.68	183	79	353.44	28	33	716.13

rected for continuity) showed that there were no significant differences at the 0.01 level, with 1 degree of freedom, in return and nonreturn rates between tag types for fish at liberty for 1, 2, or 3 yr (Table 2). However, returns were significantly better at the 0.05 level for metal tags in the third year. Further, there was no significant difference at the 0.01 level in the first-year return and nonreturn rates between the two types of dart tag, whether comparing each year individually or comparing all years combined (Table 3).

We also tested for differences in return and nonreturn rates between age-groups. Fish were aged from unpublished length-age tables (Rivas[3]). Chi-square values for fish tagged at ages 1, 2, 3, and 4+, were not significant at the 0.01 level (Table 4). The results of the chi-square test indicated that tag types and ages could be combined.

Unweighted and weighted linear regression models were used to estimate immediate tag shedding rate $(1 - \rho)$ and instantaneous shedding rate (L) (Table 5). The unweighted model for both tags combined yielded an estimate of immediate tag shedding $(1 - \rho)$ to be 0.040 (0.042 for the weighted model). The overall estimate of the instantaneous rate of tag shedding (L) on an annual basis using the model was 0.205 (0.186 for the weighted model). (The annual rate analog for L from the unweighted model is 0.19.) Therefore, the results from each model were similar. We chose to use the unweighted results, which give a slightly higher $\hat{L}$ value. While results of the chi-square test indicated that tag types could be combined, estimates were also made for each tag type separately to

[3] L. R. Rivas, Southeast Fisheries Center Miami Laboratory, Natl. Mar. Fish. Serv., NOAA, 75 Virginia Beach Drive, Miami, FL 33149.

TABLE 2.—Chi-square tests (df = 1) of equality of yearly return and nonreturn rates between double-tagged releases for 1971-77 combined, for k = 1, 2, or 3 yr at liberty, using plastic or metal dart tags on bluefin tuna in the northwestern Atlantic Ocean. The number of returns of double-tagged fish retaining both tags is n_{ddk} and those retaining only one tag is n_{dsk}.

	Plastic dart tags			Metal dart tags			
Return year (k)	Double-tagged releases	Total returns kth year ($n_{ddk} + n_{dsk}$)	Return rate	Double-tagged releases	Total returns kth year ($n_{ddk} + n_{dsk}$)	Return rate	Chi-square value
1	1,528	78	0.05105	1,593	88	0.05524	0.272
2	1,450	125	0.08621	1,505	137	0.09103	0.213
3	1,325	21	0.01585	1,368	40	0.02924	5.452*
		Average	0.05104			0.05850	

*$P \leq 0.05$.

TABLE 3.—Chi-square tests (df = 1) of equality of return and nonreturn rates between double-tagged releases recaptured the same year using plastic or metal dart tags on bluefin tuna in the northwestern Atlantic Ocean. The number of returns of double-tagged fish retaining both tags during the first year after release is n_{dd1}, and those retaining only one tag is n_{ds1}.

	Plastic dart tags			Metal dart tags			
Year	Double-tagged releases	Total returns same year ($n_{dd1} + n_{ds1}$)	Return rate	Double-tagged releases	Total returns same year ($n_{dd1} + n_{ds1}$)	Return rate	Chi-square value
1971	150	4	0.02667	162	5	0.03086	0.049
1972	75	6	0.08000	77	1	0.01299	3.884*
1973	134	20	0.14925	131	17	0.12977	0.209
1974	629	29	0.04610	666	30	0.04505	0.008
1975	50	1	0.02000	58	1	0.01724	0.011
1976	267	14	0.05243	271	26	0.09594	3.699
1977	223	4	0.01794	228	8	0.03509	1.280
Total	1,528	78	0.05105	1,593	88	0.05524	0.272

*$P \leq 0.05$

TABLE 4.—Chi-square tests (df = 1) of equality of return and nonreturn rates by estimated age between double-tagged releases for all years 1971-77 combined, recaptured the same year, using plastic or metal dart tags on bluefin tuna in the northwestern Atlantic Ocean. The number of returns of double-tagged fish retaining both tags during the first year after release is n_{dd1} and those retaining only one tag is n_{ds1}.

	Plastic dart tags			Metal dart tags			
Estimated age at release	Double-tagged releases	Total returns same year ($n_{dd1} + n_{ds1}$)	Return rate	Double-tagged releases	Total returns same year ($n_{dd1} + n_{ds1}$)	Return rate	Chi-square value[1]
1	641	29	0.04524	647	31	0.04791	0.052
2	631	43	0.06815	656	43	0.06555	0.035
3	212	4	0.01887	226	12	0.05310	3.642
4+	44	2	0.04545	64	2	0.03125	0.148
	1,528	78		1,593	88		

[1]No values significant at $P \leq 0.05$.

TABLE 5.—Estimates of immediate $(1 - \hat{p})$ and annual instantaneous $(\hat{L})$ tag shedding rates for northwestern Atlantic bluefin tuna double-tagging study for all years combined (1971-77) based on a 3-yr return period using unweighted and weighted linear regression models. (The weights used in the weighted model were equated to the ratio of the number of returns of double-tagged fish during each return period to the total number of returns of double-tagged fish during all periods.)

Model and tag type	$1 - \hat{p}$	$\hat{L}$ (annual)
Linear regression:		
Plastic dart	0.027	0.22886
Metal dart	0.049	0.19201
Combined	0.040	0.20452
Weighted linear regression:		
Plastic dart	0.033	0.19200
Metal dart	0.049	0.18213
Combined	0.042	0.18596

indicate the magnitude of the variances of the estimates.

Our estimate of $(1 - \rho)$ is slightly greater than the overall estimate of 0.027 given for bluefin tuna from the northwest Atlantic by Lenarz et al. (1973). The difference is small relative to the precision of the estimates. Our estimate of $(1 - \rho)$ for northwest Atlantic bluefin tuna is less than the value of 0.10 reported for Pacific yellowfin tuna by Bayliff and Mobrand (1972) and the value of 0.12 reported for North Pacific albacore by Laurs et al. (1976).

Our estimate of L is less than the overall estimate of 0.31 reported by Lenarz et al. (1973) for bluefin tuna and the L estimate of 0.278 reported for yellowfin tuna by Bayliff and Mobrand (1972). Our L estimate is greater than the estimates of between 0.086 and 0.098 reported for albacore by Laurs et al. (1976).

As previously noted, there was no significant difference in return rates found for the two types of dart tags for 1971-77. However, from examination of the data presented in Table 1, there appeared to be changes occurring in the shedding rates of each type of tag and a difference between the 1971-73 and 1974-77 time intervals. Therefore, we calculated $(1 - \hat{p})$ and $\hat{L}$ for each time interval and conducted chi-square tests ($df = 6$) for differences in returns over three recapture periods ($k = 3$) between time intervals and between tag types (Table 6). We found significant differences between time intervals for each of the tag types and significant differences between tag types for each of the time intervals. The plastic dart tags became less efficient, i.e., $\hat{L}$ increased over the time intervals, and the metal dart tags improved, i.e., $\hat{L}$ decreased over the time intervals.

The model of Chapman et al. (1965), which was modified by Bayliff and Mobrand (1972), assumes constant L over recapture periods. We decided to examine values of L over the two pairs of recapture periods $k = (1, 2)$ and $k = (2, 3)$ to determine how well our data fit the model. Since only two recapture periods were used, L and $(1 - \rho)$ were estimated by solving two simultaneous equations.

TABLE 6.—Estimates of immediate $(1 - \hat{p})$ and annual instantaneous $(\hat{L})$ tag shedding rates for northwestern Atlantic bluefin tuna double-tagging study for time intervals 1971-73 and 1974-77 based on a $k = 3$-yr return period. (A contingency table, 7×2, was constructed containing the number of double and single returns for each of the three recapture periods plus the number of nonreturns for each tag type and each time interval.) Results of chi-square tests ($df = 6$) for differences in double and single tag returns and total nonreturns between time intervals and tag types over a 3-yr recapture period are given.

Tag type and time interval	$1 - \hat{p}$	$\hat{L}$ (annual)	Chi-square value
Plastic dart:			
1971-73	0.029	0.14838	64.286**
1974-77	0.023	0.28455	
Metal dart:			
1971-73	0.140	0.37163	33.489**
1974-77	0.007	0.17242	
1971-73:			
Plastic dart	0.029	0.14838	18.924**
Metal dart	0.140	0.37163	
1974-77:			
Plastic dart	0.023	0.28455	18.135**
Metal dart	0.007	0.17242	

$^{**}P \leq 0.01$.

For the tag types and time intervals examined, there is an indication that $\hat{L}$ is not constant (Table 7). In fact, $\hat{L}$ increased in three out of four cases. The sequence of events could have happened due to chance alone, for if the changes in $\hat{L}$ came from a binomial distribution with $P = 0.5$, then the probability of $\hat{L}$ decreasing in three of the four cases or $\hat{L}$ increasing in three of the four cases is ≤ 0.25. However, $\hat{L}$ during the second time period is more than 60% $>\hat{L}$ in the first time period in three cases and only 16% $<\hat{L}$ in the first time period in the other case. While the data do not provide conclusive evidence that L is not constant, it would be dangerous to extrapolate beyond the time period used for analysis.

We previously noted that the 1974 releases were

TABLE 7.—Estimates of annual instantaneous $(\hat{L})$ tag shedding rates for northwestern Atlantic bluefin tuna double-tagging study for 1971-73 and 1974-77 based on return periods of $k = (1, 2)$ and $k = (2, 3)$.

Tag type and time interval	Return period k	$\hat{L}$ (annual)
Plastic 1971-73	1, 2	0.16017
	2, 3	0.13421
Plastic 1974-77	1, 2	0.09925
	2, 3	0.45207
Metal 1971-73	1, 2	0.27858
	2, 3	0.45271
Metal 1974-77	1, 2	0.09331
	2, 3	0.24632

unique in that three individuals conducted the tagging operation, whereas only one individual tagged and released the remainder of the fish from the other years. Therefore, we analyzed the data from the time intervals 1971-73 and 1975-77 separately from the 1974 data. For the following reasons we decided to examine only two recapture periods, $k = (1, 2)$: 1) 1977 has only two recapture periods possible (Table 1); 2) the number of single as well as double returns for $k = 3$ for both 1971-73 and 1975-77 constitutes very small sample sizes (Table 1); and 3) L appears to have been changing over $k = (1, 2)$ to $k = (2, 3)$ (Table 7).

Our analysis showed (Table 8) that there was a significant difference in return and nonreturn rates between time intervals for each type of dart tag. Also a significant difference in shedding rates was found between the plastic and metal type tags during the time interval 1971-73. A small sample size may account for the lack of a significant difference in shedding rates for each type of tag during the time interval of 1975-77. There also was no significant difference found in the shedding rates between each tag type during 1974. As previously mentioned, fish were released under different circumstances during 1974. During the 1971-73 time interval, plastic tags were found to be superior. We again found that the metal tag improved (Table 8), i.e., $\hat{L}$ decreased, between 1971-73 and 1975-77.

TABLE 8.—Estimates of immediate ($1 - \hat{p}$) and annual instantaneous ($\hat{L}$) tag shedding rates for northwestern Atlantic bluefin tuna double-tagging study for 1971-73, 1974, and 1975-77 based on a k = 2-yr return period. (A contingency table, 7 × 2, was constructed containing the number of double and single returns for each of the three recapture periods plus the number of nonreturns for each tag type and each time interval.) Results of chi-square tests (df = 4) for differences in double and single tag returns and total nonreturns between time intervals and tag types over a 2-yr recapture period are given. (Results for the period 1971-72 from Lenarz et al. (1973) are shown for comparison.)

Tag type and time interval	$1 - \hat{p}$	$\hat{L}$	Chi-square value
Plastic dart:			
1971-73	0.028	0.16017	39.460**
1975-77	0.118	<0.	
Metal dart:			
1971-73	0.169	0.27858	22.186**
1975-77	0.114	0.05860	
1971-73:			
Plastic dart	0.028	0.16017	17.323**
Metal dart	0.169	0.27858	
1974:			
Plastic dart	0.067	0.22615	8.318
Metal dart	0.031	0.12126	
1975-77:			
Plastic dart	0.118	<0.	6.636
Metal dart	0.114	0.05860	
1971-72:			
Plastic dart	0.000	0.21615	
Metal dart	0.099	0.26278	

**$P \leq 0.01$.

Also, $\hat{L}$-values for the plastic tag decreased, but results yielded a negative value for the 1975-77 time interval, which is theoretically impossible and is due to variability in the data.

From our analysis, we cannot conclusively show that one of the two types of dart tags is better for bluefin tuna tagging. Both tag types appeared to improve between 1971-73 and 1975-77. Plastic tags were significantly better than metal in the first period and nonsignificantly better in the second.

We have shown that tag shedding rates vary from 1 yr to another. There are some possible reasons for the observed variability. One reason may be changes in tag design or quality. To our knowledge there was no intentional effort made by the manufacturers to change the design of the metal or plastic dart tags used in this study. A different type of glue, however, was used during 1972 through 1977 for the plastic dart tags. Before using the plastic dart tags, we tested them by pulling on the barb. On several occasions, we discovered that the barbs were not adequately secured. We reglued these tags before using them. We also examined the metal dart tags prior to their use. In general, they appeared to be trouble free. Several orders of both types of tags were used during the course of this study. We were unable to correlate changes in the shedding rates with the specific batch of tags that were used. The shelf life of the plastic used in the tags may be another factor. In some instances we used tags which were manufactured several years before their actual use. Since there were no changes in the tagging method, this reason was discounted. Tagging occurred throughout the purse seine fishing season during 1971, 1973, and 1974, and at the end of the season during 1972, 1975, 1976, and 1977. We do not see why this would have more of an effect on one type of tag than on the other.

Summary and Conclusions

Return data for double-tagged northwestern Atlantic bluefin tuna were used to estimate the shedding rates of plastic and metal dart tags. No significant difference was found between the return rates of the plastic and metal tags when the data were tested for all years combined, but plastic tags appeared to have lower shedding rates than metal tags in most cases. We believe that the combining of the data of all years together (1971-77) probably yields a reasonable approximation to the average shedding rate for each type of tag. Type-I shedding, which occurs immediately after release, was estimated to be 0.040 for plastic and metal dart tags combined. Type-II (instantaneous) shedding was estimated to be 0.205 for plastic and metal tags combined on an annual basis.

The shedding rates for each type of tag were found to vary over the time period studied, and deviations from the assumption of constant shedding throughout the life of the tagged fish were noted. Due to these differences, one should not be satisfied with the results of one double-tagging experiment. We recommend that double tagging be employed whenever possible, as long as shedding occurs and the rate of shedding is found to vary. Also, tagged fish, especially the ones which have been at liberty for a long time, are more likely to continue to carry at least one tag if they were originally double tagged. The ones that do not continue to carry at least one tag are of no value. Furthermore, relative to the errors inherent in a study of this type we do not feel that there is really any important difference in shedding rates between the plastic and metal dart tags.

Since shedding may increase with time from release, extrapolations based on the assumption of constant L should be made with caution. Also because the tag shedding rates that we found are considerable, efforts should be made to develop a more efficient type of tag with a lower rate of shedding.

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RAYMOND E. BAGLIN, JR.

Southeast Fisheries Center Miami Laboratory
National Marine Fisheries Service, NOAA, Miami, Fla.
Present address: *National Marine Fisheries Service, NOAA*
c/o Alaska Department of Fish and Game
P.O. Box 686, Kodiak, AK 99615

MARK I. FARBER

Southeast Fisheries Center Miami Laboratory
National Marine Fisheries Service, NOAA
75 Virginia Beach Drive, Miami, FL 33149

WILLIAM H. LENARZ

Southwest Fisheries Center Tiburon Laboratory
National Marine Fisheries Service, NOAA
3150 Paradise Drive, Tiburon, CA 94920

JOHN M. MASON, JR.

Woods Hole Oceanographic Institution, Woods Hole, Mass.
Present address: *Mid-Atlantic Fishery Management Council*
Federal Building, North and New Streets
Dover, DE 19901

INFLUENCE OF LITTLE GOOSE DAM ON UPSTREAM MOVEMENTS OF ADULT CHINOOK SALMON, *ONCORHYNCHUS TSHAWYTSCHA*

A major environmental and economic concern in the Pacific Northwest is the continuing decline in the numbers of Columbia and Snake River salmonids. Several investigators (Johnson 1960 and others) have used biotelemetry to study effects of hydroelectric dams (Figure 1) on the upstream movements of adult salmonids. Results indicated upstream movements were delayed at Bonneville (Schoning and Johnson[1]; Monan and Liscom[2,3,4,5]),

[1]Schoning, R. W., and D. R. Johnson. 1956. A measured delay in the migration of adult chinook salmon at Bonneville Dam on the Columbia River. Fish. Comm. Oreg., Contrib. No. 23, 16 p.

[2]Monan, G. E., and K. L. Liscom. 1971. Final report, radio tracking of adult spring chinook salmon below Bonneville Dam,