SCRS/1979/084 Col.Vol.Sci.Pap. ICCAT, 9 (2): 453-462 (1980)

ESTIMATES OF SHEDDING RATES OF TWO TYPES OF DART TAGS FROM NORTHWESTERN ATLANTIC BLUEFIN TUNA (THUNNUS THYNNUS)

R. E. Baglin, M. I. Farber, W. H. Lenarz, J. M. Mason

SUMMARY

Return data for double-tagged northwestern Atlantic bluefin tuna, Thunnus thynnus, 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 analyzed for 1971-77, though plastic tags appeared to have lower shedding rates than metal tags. Type-I shedding, which occurs immediately after release, was estimated to be 0.040 for plastic and metal dart tags combined. Type-II shedding, which is the instantaneous rate, 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.

RESUME

Des données sur les récupérations de marques doubles apposées sur des thons rouges (*Thunnus thynnus*) dans l'Atlantique nord-ouest ont été utilisées pour estimer le taux de rejet de marques à dard en plastique et en métal. Lors de l'analyse des données pour 1971-77, aucune différence significative n'a été observée entre le taux de récupération des deux types de marques, bien que ceux en plastique semblent être moins facilement rejetés. On a estimé que le degré de rejet de type I, qui se produit juste après le marquage, était de 0,040 pour les deux sortes de marques prises en bloc; pour le type II, taux instantané, l'estimation est de 0,205 pour les deux sortes de marques combinées sur une base annuelle. On a observé que le degré de rejet de chacun de ces deux modèles avait varié au cours de la période étudiée; on a pris note d'écarts à l'hypothèse d'un taux constant de rejet pendant toute la vie du poisson.

RESUMEN

Fueron utilizados datos recuperados del atún rojo marcado doblemente en el Atlántico, Thunnus thynnus, para estimar las tasas de pérdida de marcas dardo, métalicas y de plástico. No se encontraron diferencias significantes entre las tasas de recuperación de marcas plastificadas o metalicas, cuando se analizaron los datos para 1971-77 si bién las marcas de plástico parecen tener unas tasas de pérdidas más baja que las metálicas. La pérdida tipo I suele ocurrir después de la liberación, se estimaron del 0.040, para ambas marcas dardo (plástico o metal). Pérdida tipo II, que es de tasa instantánea, se estimó es del 0.205 para ambas marcas (plastificadas y metálicas) sobre unas bases anuales. Las tasas de pérdida para cada tipo de marca, se encontró varian sobre el periodo de tiempo estudiado y se observan desviaciones de la hipótesis de constantes pérdidas a lo largo de la vida del pez marcado.

INTRODUCTION

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 results obtained through 1972, for 580 double-tagged bluefin 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 which were slightly different from 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. 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.

MATERIALS AND 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 and Laurs et al. (1976) used for north Pacific albacore.

Bayliff and Mobrand's equations[1] for tag returns are:

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

$$n_{dsk} = 2F\tau N_D \pi\rho(1-\rho e^{-Lt_k})e^{-(F + X + L)t_k} \quad (2)$$

[1] As pointed out by Laurs et al. (1976), there was a typographical error in both Bayliff and Mobrand (1972) and Lenarz et al. (1973) in equation (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 $(k = 1,2,3)$.

Bayliff and Mobrand (1972), using equations (1) and (2), showed:

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

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, 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 this 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: (i) equality of return rates for same year recaptures; (ii) equality of return rates by estimated age; and (iii) differences in returns and non-returns over 2 or 3 year 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 showed that there were no significant differences at the 0.01 level, with one degree of freedom, in return rates between tag types for all years combined for returns from each k year (Table 2). However, returns were significantly better at the 0.05 level for metal tags in the third year. A contingency table (7 x 2) was constructed containing the number of double and single returns for each of the three

recapture periods plus the number of non-returns for each tag type. The calculated chi-square value with 6 degrees of freedom was 6.277, which was not significant at the 0.01 level. Further, there was no significant difference at the 0.01 level in the first-year return rates between the two types of dart tag, whether comparing each year individually or comparing all years combined (Table 3). The calculated chi-square value for the first-year returns for all years combined was 0.273 (Table 3).

We also tested for differences in return rates between age groups. Fish were aged from unpublished length-age tables by NMFS, Miami, Fla. Chi-square values for fish tagged at ages 1, 2, 3, and 4+, respectively, were not significant at the 0.01 level (Table 4).

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 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). Therefore, the results from each model were similar. We chose to use the unweighted results, which give a slightly higher $\hat{L}$ value.

Our estimate of $1-\rho$ is greater than the overall estimate of 0.027 given for bluefin tuna from the northwest Atlantic by Lenarz et al. (1973). Their estimate was based on a much smaller sample size taken over only a 2-year period. Our estimate of $1-\rho$ for northwest Atlantic bluefin 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 and the L estimate of 0.278 reported for yellowfin 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, examination of the data presented in Table 1 suggested that there might be changes occurring in the shedding rates of each type of tag. There appeared to be a difference between the 1971-73 and the 1974-77 time intervals. Therefore, we calculated $1-\hat{\rho}$ 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.

For the tag types and time intervals examined $\hat{L}$ is not constant (Table 7). In fact, $\hat{L}$ increased in three out of the four cases. While this sequence of events could have occurred due to chance alone ($p \leq 0.25$, binomial distribution), $\hat{L}$ during the second time period is more than 60% greater than $\hat{L}$ in the first time period in three cases and only 16% less than $\hat{L}$ 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.[2]

We previously noted that the 1974 releases were 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): (i) 1977 has only two recapture periods possible (Table 1); (ii) 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 (iii) 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 between time intervals for each type of dart tag. Also a significant difference 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

---

[2] Jerry Wetherall, Southwest Fisheries Center, National Marine Fisheries Service, NOAA, Honolulu, Hawaii 96812, has proposed and is investigating modifications of equations (1) and (2) that allow L to change linearly with time.

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. 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 non significantly better in the second.

We have shown that tag shedding rates vary from one year 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.

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.

ACKNOWLEDGMENTS

We thank W.H. Bayliff of the Inter-American Tropical Tuna Commission and J. Wetherall of the NMFS Southwest Fisheries Center, Honolulu Laboratory for their helpful comments on the manuscript.

We also thank all captains and crewmen of commercial and sport fishing vessels, NMFS technicians who participated in the bluefin tagging program, and T. Chewning of the Southeast Fisheries Center for computer programming assistance.

LITERATURE CITED

Bayliff, W.H. and L.M. Mobrand.

1972. Estimates of the rates of shedding of dart tags from yellowfin tuna. Inter -Am. Trop. Tuna Comm., Bull. 15:439-462.

Chapman, D.G., B.D. Fink, and E.B. Bennett.

1965. A method for estimating the rate of shedding of tags from yellowfin tuna. [In Engl. and Span.] Inter -Am. Trop. Tuna Comm., Bull. 10: 333-352.

Food and Agriculture Organization.

1972. Final report of the working party on tuna and billfish tagging in the Atlantic and adjacent seas. FAO Fish. Rep. 118, Suppl. 1, 37 p.

Laurs, R.M., W.H. Lenarz, and R.N. Nishimoto.

1976. Estimates of rates of tag shedding by North Pacific albacore, Thunnus alalunga. Fish. Bull., U.S. 74:675-678.

Lenarz, W.H., F.J. Mather III, J.S. Beckett, A.C. Jones, and J.M. Mason, Jr.

1973. Estimation of rates of tag shedding by northwest Atlantic bluefin tuna. Fish. Bull., U.S. 71:1103-1105.

Table 1.- Tag releases and returns from northwestern Atlantic bluefin tuna double tag study.

Tag Type	Double-Tag Releases Year	Double-Tag Releases Number	First-year returns n_{dd1}	n_{ds1}	t_1 (days)	Second-year returns n_{dd2}	n_{ds2}	t_2 (days)	Third-year returns 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 (E-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
Plastic and Metal dart	Total	3,121	144	22	17.68	183	79	353.44	28	33	716.13

Table 2.- Chi-square tests (df = 1) of equality of return rates between double-tagged releases for 1971-77 combined, for k-return years, using plastic or metal dart tags on bluefin tuna in the northwestern Atlantic Ocean.

Return Year k	Plastic Dart Tags: Double-Tag Releases	Total Returns k-th Year ($n_{ddk} + n_{dsk}$)	Return Rate	Metal Dart Tags: Double-Tag Releases	Total Return k-th 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	

*Significant at 0.05 level.

Table 3.- Chi-square tests (df = 1) of equality of return rates between double-tagged releases recaptured the same year using plastic or metal dart tags on bluefin tuna in the northwestern Atlantic Ocean.

Year	Plastic Dart Tags: Double-Tag Releases	Total Returns Same Year ($n_{dd1} + n_{ds1}$)	Return Rate	Metal Dart Tags: Double-Tag 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	0.273

*Significant at 0.05 level.

Table 4.- Chi-square tests (df = 1) of equality of return 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.

Estimated Age at Release	Plastic Dart Tags: Double-Tag Releases	Total Returns Same Year ($n_{dd1} + n_{ds1}$)	Return Rate	Metal Dart Tags: Double-Tag Releases	Total Returns Same Year ($n_{dd1} + n_{ds1}$)	Return Rate	Chi-square Value
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		

Table 5.- Estimates of immediate (1-β) 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-year return period using unweighted and weighted linear regression models.

Model and Tag Type	1-β	$\hat{L}$ (annual)
Linear Regression		
Plastic dart	0.027	0.22886
Metal dart	0.049	0.19201
Total	0.040	0.20452
Weighted Linear Regression		
Plastic dart	0.033	0.19200
Metal dart	0.049	0.18213
Total	0.042	0.18596

Table 6.- Estimates of immediate (1-β) 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-year return period. Results of chi-square tests (df = 6) for differences in returns and total non-returns over k = 3 between time intervals and tag types are given.

Tag type and interval	1-β	$\hat{L}$ (annual)	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	

**Significant at 0.01 level.

Table 7.- Estimates of 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 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

Table 8.- Estimates of immediate (1-β) and annual instantaneous ($\hat{L}$) tag shedding rates for northwest Atlantic bluefin tuna double-tagging study for time intervals 1971-73, 1974, and 1975-77 based on a k = 2-year return period. Results of chi-square tests (df = 4) for differences in returns and total non returns over k = 2 between time intervals and tag types are given. (Results for the period 1971-72 from Lenarz et al. (1973) are given for comparison.)

Tag type and Time Interval	1-β	$\hat{L}$	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	

**Significant at 0.01 level.