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THE 1981 DEER PELLET GROUP SURVEYS*

by G. E. Burgoyne, Jr. and M. L. Moss

ABSTRACT

In 1981, the deer pellet group survey was carried out in all of Michigan's northern deer range. The area surveyed includes the Upper Peninsula and the northern half of the Lower Peninsula. The average over-winter deer population in the Upper Peninsula was estimated to be 287,230 animals, while the average over-winter population in the northern half of the Lower Peninsula was estimated to be 403,250 animals. After legal kill and over-winter losses are taken into account, the two regional, corresponding spring deer population estimates, prior to fawning, were 279,834 animals and 382,389 animals.

INTRODUCTION

Free ranging wildlife populations are difficult to sample. The animals' abilities to run and to hide not only make them difficult to capture, but also make them very difficult to observe. Hence, wildlife biologists have determined that the best method for judging the density of white-tailed deer (*Odocoileus virginianus*) is to make counts of some sign that the deer leave. Deer droppings or pellet groups seem to be best suited for systematic appraisal. This technique is simply a formalized extension of methods used by experienced hunters to gauge the abundance of animals.

RATIONALE

The information about the density of deer pellet groups is primarily useful as an index to the abundance of deer. Bennett, English, and McCain (1940) originally used estimates of pellet group density to compare deer use on different areas. However, it may have seemed unsatisfactory to talk about pellet groups when they were actually interested in deer. Hence, biologists defined a simple relationship between the number of pellet groups on an area and the number of deer necessary to produce those groups. This relationship was then used to mathematically convert pellet groups per acre into deer per square mile or deer per section.

In order to estimate a deer population we need to know (1) the rate that pellet groups are produced, (2) the number of pellet groups present, and (3) the period during which they were deposited. Studies with penned deer indicated that deer defecate on the average about 13 times in a 24-hour period. Thus, the total pellet groups on an area divided by 13 provides an estimate of the number of deer-days of use. Then if we can determine the period over which groups were deposited, we can estimate the number of deer present (McCain 1948).

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The period of time over which the groups have been deposited is defined to begin after leaf fall in the autumn and to end on the average date that the sample plots were searched. Usually the leaves in any particular area are knocked from the trees during a relatively short period because of heavy winds, rain, snow, or a combination of these. Fallen leaves form a mat which hides groups dropped earlier. Thus only those groups dropped after leaf fall are visible. Leaf fall is noted for each part of the state by the local wildlife biologists. However in some areas the leaf cover is sparse, leaving it up to the biologists to separate the new pellet groups from the old.

The actual relationship between deer density and pellet group density is much more complex. It is affected by many factors, including weather and diet and composition of the deer herd. Since the exact form of this relationship is unknown, the new figure which is calculated is not an exact number of deer, but it is, at least, an improved population index (Overton 1969). However, experiments have shown that the simple relationship is a reasonable approximation of the true relationship between pellet group density and actual deer density (Eberhardt and VanEtten 1956).

SAMPLE

The northern deer range in Michigan encompasses an area of roughly 35,000 square miles. Since it is virtually impossible, and far too expensive, to search the entire area, a sampling plan must be formulated. Basically, the area is classified by the field biologists into three categories of deer abundance. Then the three categories (strata) are separately sampled. The number of samples allocated to each category depends on the area included in the category and the variability observed within the strata. The survey is primarily designed to produce estimates for the two northern Regions: Region I is the Upper Peninsula and Region II is the northern Lower Peninsula. However, the survey is designed so that estimates for the four districts within each of the Regions are a convenient intermediate product.

This sampling design is called stratified sampling. Stratified sampling does not introduce any personal bias into the survey, but does provide more precise estimates with less effort (man-power). Stratification is merely a method of insuring that the greatest effort is spent where it will do the most good.

The entire deer range is divided into about 35,000 first stage sampling units: sections. Typically, sections are one square mile. Due to land survey corrections and lake shores, some sections may contain less than one square mile of land area. This survey design assumes that only sections which contain more than one-half square mile of land area are available for sampling. Hence the number of sections in a district may not agree exactly with the district's land area.

The sections to be sampled are determined by random selection. Each section within a stratum within a district has the same chance of being selected.

Second stage samples are areas located in each randomly selected section. These are a series of five 1/50-acre rectangular plots (12' x 72.6').

The five plots together make up a "course." The midpoint of each end of the plot is marked with a wooden stake.

COMPUTATIONS

The survey estimates the average number of deer pellet groups to be found on any randomly selected course in the Region. In Table 5, we change the average groups per course to groups per section and then convert this estimate to total deer. Dividing the average groups per course by five gives the average groups per plot (a course consists of five plots). This value is multiplied by 50 to calculate average groups per acre (the plots are 1/50-acre). Then multiplying by 640 estimates groups per section. This is converted to deer by dividing the groups by the deposition rate to give deer-days and then by the number of days to give the average number of deer present for the period. These figures are termed "unadjusted deer in district." The calculations are shown in a simplified formula at the bottom of the table. The unadjusted figure is an estimate of the average over-winter deer population.

Less deer than the unadjusted estimate (Table 5) are actually present in spring. Deer which die during the deposition period also contribute pellet groups. For example, four deer which each live for one month will contribute about the same number of pellet groups as two deer which each live for two months or one deer which lives for four months. To correct for this we subtract the pellet groups deposited by deer which do not survive the entire pellet deposition period. Deer killed during the regular deer season dropped pellet groups for about a month before being shot and these groups were included in the total estimate of pellet groups. Their contributions must be deducted for the period they were present. This same process is used for other losses to calculate the spring herd estimate. Then the estimated number of deer lost during the deposition period, not their contributions, are added to the estimated spring herd to get the previous fall's herd estimate. Table 7 contains these calculations.

This does not account for deer illegally killed and removed during the pellet deposition period, deer killed by archers after the leaf fall date, deer taken on camp deer licenses, or deer killed in the muzzleloader season. These legal deer kills are known to be relatively small, but the illegal removal is of unknown, but perhaps sizable proportions. In effect, this means that the actual fall population is somewhat larger than the figure given and the spring populations somewhat smaller.

The estimates of legal deer kill are from mail surveys (Ryel 1981), and the estimates of over-winter deer losses are district Wildlife biologists' best qualitative estimates. In some years when losses are expected to be especially high, a large-scale survey is undertaken to quantitatively estimate these over-winter losses (Burgoyne and Moss 1978, 1979).

The estimates are summarized in Table 1 and Figure 1. Data for the Upper Peninsula and northern Lower Peninsula are also compared with previous years in Tables 2 and 3. The estimated spring deer densities by stratum for each district are found in Table 4.

SOURCES AND CONTROL OF ERROR

The number of deer is not constant from section to section across the state. Likewise, the number of pellet groups also varies from one course to another. The amount and direction of these variations are due to chance and are termed sampling errors. The deer pellet group survey, like all sampling techniques, is subject to many sources of error in addition to chance or sampling errors.

These non-random errors or biases arise in counting and aging the pellet groups, in estimating deer defecation rates and leaf fall dates, and in sampling error. Ryel (1959), Eberhardt (1960), and VanEtten and Bennett (1965) discuss these problems in some detail. It appears that the actual determination of (1) the number of pellet groups present on a sample plot and (2) their relative age, is responsible for a large share of the variations in survey results. Errors in estimating the defecation rate and in estimating the leaf fall date do not appear to contribute major errors to the final estimate.

Ideally, to reduce counting errors and misidentification of pellet age to a minimum, a few experienced individuals should search all of the courses each year. This is not possible because of the effort involved and the time limits imposed. Therefore, a recheck system is used. On the 1956, 1957, and 1958 pellet group surveys, all plots were originally searched by one man. As a recheck, 20 percent of the courses were randomly selected and searched a second time by an experienced biologist. Discrepancies between the original counts and the rechecks resulted in increasing the estimates of the total deer population by 30 percent in the northern Lower Peninsula in 1956, by 1 percent in this area in 1957, and by 16 percent in the Upper Peninsula in 1957 (Eberhardt 1957).

We employ a system of "concurrent" rechecks on the surveys. This involves making independent counts on all plots by members of two-man crews and then arriving at a composite count. Crew members start at opposite ends of the plot and count pellet groups on the half plot to their right. Metal disks are used to mark all groups found. Searchers then switch sides and check their partner's work. The biologists on the crews are responsible for classifying pellets into age categories and making final decisions on the number of groups present. Where a crew has only one biologist (the usual case), there is no real check on his identification of old and new groups.

We have not found consistent characteristics to distinguish pellet groups dropped prior to leaf fall from those dropped after leaf fall. This means that we must use the relationship of the groups to fallen leaves and ground vegetation whenever possible. Where this is not feasible, as in grasslands, oak stands, conifer swamps, etc., we must depend on the searcher's ability to make correct judgments on the age of questionable groups.

We can get some notion of the magnitude of these errors by comparing the ratios of old to new pellet groups between districts within the various strata. Unfortunately, such comparisons are complicated by changes in weather, changes in deer use, and changes in deer foods among the various districts and between years. Thus, we cannot be sure that any differences we find are due to human error alone.

STATISTICAL CALCULATIONS

Table 6 contains the summaries of the statistical analyses by district, giving stratum averages ($\bar{x}_j$), district averages ($\bar{\bar{x}}_{st}$), and stratum standard deviation s_j.

Computations for each district were made as suggested by Cochran (1953) for stratified random sampling:

$\bar{\bar{x}}_{st} = w_1\bar{x}_1 + w_2\bar{x}_2 + \ldots\ldots + w_n\bar{x}_n$ where the w_j's are the proportion of the total number of sections in each stratum and the $\bar{x}_j$'s are the stratum averages.

$v(\bar{\bar{x}}_{st}) = w_1^2\, v(\bar{x}_1) + w_2^2\, v(\bar{x}_2) + \ldots\ldots + w_n^2\, v(\bar{x}_n)$ where the w_j's are as above and $v(\bar{x}_j)$'s are variances of stratum averages $= \frac{s_j^2}{n}$.

In a similar fashion, estimates of the averages and variances were made for Region II. Here the w_j's become the proportion of the region occupied by each district, the $\bar{x}_j$'s are the district averages, and the $v(\bar{x})$'s their corresponding variances.

With a systematic subsample, the model is equivalent to a simple random sample with one element per sample. Hence, there is no estimate provided for a component of variation from plot to plot within each first stage sampling unit (section). Cochran indicates the variance estimate based on the first stage sampling unit, as derived from the second stage samples, is a valid approximation as long as n/N is "small" (less than .05 is suggested). Here n refers to the number of sections selected out of the total possible, N, in each stratum.

MANPOWER

Table 8 contains summaries of the time and people involved in carrying out the pellet survey. These tables contain person-days (effort), individuals contributed by division, and average days worked per individual.

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Figure 1

DEER PER SECTION: FALL 1980 and SPRING 1981

District	Fall 1980	Spring 1981	District	Fall 1980	Spring 1981
1	7.13	6.33	5	23.82	20.02
2	43.13	39.19	6	23.21	17.97
3	18.81	17.28	7	39.08	32.47
4	16.08	14.86	8	23.95	15.46

Table 1

SUMMARY OF ESTIMATES

District	Sections	Unadjusted deer	Legal kill	Other losses*	Deer population estimates Fall 1980	Deer population estimates Spring 1981
1	4,702	30,710	2,290	1,500	33,545	29,755
2	3,007	121,730	6,820	5,000	129,677	117,857
3	3,548	62,650	4,030	1,400	66,738	61,308
4	4,773	72,150	3,840	2,000	76,754	70,914
Total Upper Peninsula	16,030	287,230	16,980	9,900	306,714	279,834
5	4,266	88,500	13,990	2,200	101,598	85,408
6	4,697	89,130	18,707	5,910	109,023	84,406
7	4,630	157,420	22,766	7,830	180,918	150,321
8	4,028	68,200	23,727	10,500	96,481	62,254
Total Northern Lower Peninsula	17,621	403,250	79,190	26,440	488,020	382,389
Northern Michigan	33,651	690,490	96,170	36,340	794,734	662,223

*Does not include illegal kill completely removed from the field.

Due to rounding, the figures in this table may not sum exactly to the totals.

Table 2

SUMMARY OF ADJUSTED ESTIMATES

TOTAL DEER

Year of survey	Upper Peninsula		Northern Lower Peninsula	
	Previous fall	Spring	Previous fall	Spring
1971	(no survey)		225,880	160,700
1972	189,000	156,230	266,680	222,430
1973	181,530	167,410	326,050	284,630
1974	(no survey)		365,050	303,000
1975	220,690	192,760	477,250	393,750
1976	268,900	239,770	467,820	356,720
1977	319,270	288,550	449,580	359,020
1978	(no survey)		497,340	351,050
1979	157,370*	130,690*	514,590	336,360
1980	(no survey)		475,180	380,570
1981	306,714	279,834	488,020	382,389

DEER PER SECTION

1971	(no survey)		13.09	9.31
1972	11.72	9.69	15.45	12.89
1973	11.26	10.38	18.89	16.49
1974	(no survey)		21.15	17.56
1975	13.69	11.95	27.65	22.82
1976	16.61	14.81	26.30	20.05
1977	19.72	17.82	25.27	20.18
1978	(no survey)		27.96	19.73
1979	52.27*	43.40*	28.93	18.91
1980	(no survey)		26.71	21.39
1981	19.13	17.46	27.70	21.70

*District 2 ONLY.

Table 3

SUMMARY OF UNADJUSTED ESTIMATES
(Average over-winter population)

Year of survey	Upper Peninsula	Northern Lower Peninsula
1971	(no survey)	177,521
1972	167,941	230,828
1973	172,064	291,995
1974	(no survey)	316,311
1975	201,946	412,887
1976	249,696	386,869
1977	299,640	380,180
1978	(no survey)	388,470
1979	139,880 (District 2 only)	387,570
1980	(no survey)	402,910
1981	287,230	403,250

Table 4

ESTIMATED SPRING POPULATION DENSITY BY STRATUM

Stratum	District 1	District 2	District 3	District 4
I	33.58	80.46	76.06	31.39
II	11.80	58.80	28.25	31.39
III	4.90	22.67	6.27	12.65
District average	6.33	39.19	17.28	14.86

Stratum	District 5	District 6	District 7	District 8
I	61.35	51.41	58.13	32.23
II	31.25	24.64	29.30	20.23
III	7.33	11.88	21.33	4.43
District average	20.02	17.97	32.47	15.45

Table 5

UNADJUSTED POPULATION ESTIMATES*
(Average over-winter population)

District	Days from leaf fall	Avg. pellet groups/course	Avg. deer/ section	Sections in District	Unadjusted deer in District
1	195	2.6803	6.5309	4,702	30,708
2	184	15.677	40.483	3,007	121,733
3	188	6.9863	17.656	3,548	62,645
4	186	5.9173	15.115	4,773	72,146
Region I		7.0353	17.918	16,030	287,232
5	169	7.3245	20.746	4,266	88,503
6	168	6.6600	18.976	4,697	89,132
7	173	12.288	34.000	4,630	157,418
8	155	5.4827	16.932	4,028	68,202
Region II		8.0305	22.885	17,621	403,255

Upper Peninsula - Deer per section = $\frac{\text{(Avg. pellet groups/course)} \times 50 \times 640}{\text{(days from leaf fall)} \times 13.47 \times 5}$

13.47 is average pellet groups deposited per deer day in the U.P.

Northern Lower Peninsula - Deer per section = $\frac{\text{(Avg. pellet groups/course)} \times 50 \times 640}{\text{(days from leaf fall)} \times 13.37 \times 5}$

13.37 is average pellet groups deposited per deer day in the N.L.P.

$\frac{50 \times 640}{5}$ is a constant which converts the counts from "per course" to "per section."

*"Unadjusted" means that deer dying during the pellet deposition period have not been taken into account.

Table 6

STATISTICAL ANALYSIS OF DEER PELLET GROUPS PER COURSE

District	Stratum	Sections	Number of samples	Average	Standard deviation
1	I	153	9	14.222	15.490
	II	335	3	5.0000	4.3589
	III	4,214	39	2.0769	3.2958
	District average	2.6803	Standard error	.53300	
2	I	489	38	32.184	20.246
	II	593	23	23.522	28.010
	III	1,925	44	9.0682	11.639
	District average	15.678	Standard error	1.6952	
3	I	204	12	30.750	21.934
	II	1,130	19	11.421	9.0879
	III	2,214	15	2.5333	4.5805
	District average	6.9863	Standard error	1.0574	
4	I	223	18	12.500	12.580
	II	340	6	12.500	17.213
	III	4,210	54	5.0370	12.975
	District average	5.9173	Standard error	1.6417	

REGIONAL STATISTICS

Region I average	7.0353	Standard error	.64753

Table 6 (Continued)

STATISTICAL ANALYSIS OF DEER PELLET GROUPS PER COURSE

District	Stratum	Sections	Number of samples	Average	Standard deviation
5	I	326	9	22.444	20.683
	II	1,527	30	11.433	14.141
	III	2,413	44	2.6818	4.5483
	District average	7.3245	Standard error	1.1323	
6	I	517	19	19.053	22.839
	II	639	15	9.1333	10.703
	III	3,541	47	4.4043	8.1791
	District average	6.6600	Standard error	1.1327	
7	I	989	37	22.000	25.947
	II	1,903	44	11.091	12.347
	III	1,738	28	8.0714	10.569
	District average	12.288	Standard error	1.4062	
8	I	689	30	11.433	9.8740
	II	1,599	40	7.1750	7.6423
	III	1,740	7	1.5714	3.3594
	District average	5.4827	Standard error	0.7912	

REGIONAL STATISTICS

Region II average 8.0305 Standard error .57925

Table 7

ADJUSTMENTS FOR DEER REMOVALS

District 1

Deposition period - 195 days		
Unadjusted pellet group estimate (average over-winter population)		30,708
*Legal hunting kill - about 2,290 deer contributing for 32 days		- 376
**Fall and early winter losses - about 1,000 deer contributing for 45 days		- 231
**Late winter and spring losses - about 500 deer contributing for 135 days		- 346
	1981 spring populations	29,755
	hunting removal	+ 2,290
	other losses	+ 1,500
	1980 fall populations	33,545

District 2

Deposition period - 184 days		
Unadjusted pellet group estimate (average over-winter population)		121,733
*Legal hunting kill - about 6,820 deer contributing for 32 days		- 1,186
**Fall and early winter losses - about 2,000 deer contributing for 45 days		- 489
**Late winter and spring losses - about 3,000 deer contributing for 135 days		- 2,201
	1981 spring population	117,857
	hunting removal	+ 6,820
	other losses	+ 5,000
	1980 fall population	129,677

*Preliminary deer kill estimates.
**Does not include illegal kill completely removed from the field.

Table 7 (continued)

ADJUSTMENTS FOR DEER REMOVALS

District 3

Deposition period - 188 days

Unadjusted pellet group estimate (average over-winter population)		62,645
*Legal hunting kill - about 4,030 deer contributing for 33 days		- 707
**Fall and early winter losses - about 800 deer contributing for 46 days		- 196
**Late winter and spring losses - about 600 deer contributing for 136 days		- 434
	1981 spring population	61,308
	hunting removal	+ 4,030
	other losses	+ 1,400
	1980 fall population	66,738

District 4

Deposition period - 186 days

Unadjusted pellet group estimate (average over-winter population)		72,146
*Legal hunting kill - about 3,840 deer contributing for 24 days		- 495
**Fall and early winter losses - about 1,300 deer contributing for 37 days		- 259
**Late winter and spring losses - about 700 deer contributing for 127 days		- 478
	1981 spring population	70,914
	hunting removal	+ 3,840
	other losses	+ 2,000
	1980 fall population	76,754

*Preliminary deer kill estimates.
**Does not include illegal kill completely removed from the field.

Table 7 (continued)

ADJUSTMENTS FOR DEER REMOVALS

District 5

Deposition period - 169 days

Unadjusted pellet group estimate (average over-winter population)		88,503
*Legal hunting kill - about 13,990 deer contributing for 24 days		- 1,987
**Fall and early winter losses - about 1,000 deer contributing for 36 days		- 213
**Late winter and spring losses - about 1,200 deer contributing for 126 days		- 895
	1981 spring population	85,408
	hunting removal	+13,990
	other losses	+ 2,200
	1980 fall population	101,598

District 6

Deposition period - 168 days

Unadjusted pellet group estimate (average over-winter population)		89,132
*Legal hunting kill - about 18,707 deer contributing for 24 days		- 2,672
**Fall and early winter losses - about 4,440 deer contributing for 36 days		- 951
**Late winter and spring losses - about 1,470 deer contributing for 126 days		- 1,103
	1981 spring population	84,406
	hunting removal	+18,707
	other losses	+ 5,910
	1980 fall population	109,023

*Preliminary deer kill estimates.
**Does not include illegal kill completely removed from the field.

Table 7 (continued)

ADJUSTMENTS FOR DEER REMOVALS

District 7

Deposition period - 173 days

Unadjusted pellet group estimate (average over-winter population)	157,418
*Legal hunting kill - about 22,766 deer contributing for 23 days	- 3,027
**Fall and early winter losses - about 3,053 deer contributing for 35 days	- 618
**Late winter and spring losses - about 4,778 deer contributing for 125 days	- 3,452
1981 spring population	150,321
hunting removal	+22,766
other losses	+ 7,831
1980 fall population	180,918

District 8

Deposition period - 155 days

Unadjusted pellet group estimate (average over-winter population)	68,202
*Legal hunting kill - about 23,727 deer contributing for 18 days	- 2,755
**Fall and early winter losses - about 8,500 deer contributing for 30 days	- 1,645
**Late winter and spring losses - about 2,000 deer contributing for 120 days	- 1,548
1981 spring population	62,254
hunting removal	+23,727
other losses	+10,500
1980 fall population	96,481

*Preliminary deer kill estimates.
**Does not include illegal kill completely removed from the field.

Table 8

SUMMARY OF EFFORT

Person-days by District

Source	District 1	2	3	4	5	6	7	8	Total	Percent
Wildlife -										
Staff				9	8	12	7	2	38	6.04
Field	37	85	36	68	60	63	68	34	451	71.70
Research		12		4			16		32	5.09
Admin. Serv.		1			1				2	0.32
Air Quality							1		1	0.16
Fisheries							1		1	0.16
Forest Mgmt.	3		3	2	4				12	1.91
Land Res. Prog.							4		4	0.63
Law Enforcement	1	1	2		4			1	9	1.43
Resource Recovery							1		1	0.16
Spec. Field Serv.							1		1	0.16
Waterways		3							3	0.48
U.S. Forest Serv.	8	1	1						10	1.59
Federal Programs (YACC, etc.)	10	3	12	15	3		1	3	47	7.47
Other (volunteer)	1	5	2		2	4	3		17	2.70
TOTAL	60	111	56	98	82	79	103	40	629	

Individuals Participating

Source	District 1	2	3	4	5	6	7	8	Total
Wildlife -									
Staff				3	1	5	4	1	13*
Field	3	7	6	7	9	8	8	7	55
Research		4		2			7		13
Admin. Serv.		1			1				2
Air Quality							1		1
Fisheries							1		1
Forest Mgmt.	2		1	1	4				8
Land Res. Prog.							2		2
Law Enforcement	1	1	2		3			1	8
Resource Recovery							1		1
Spec. Field Serv.							1		1
Waterways		2							2
U.S. Forest Serv.	4	1	1						6
Federal Programs (YACC, etc.)	2	1	3	3	2		1	2	14
Other (volunteer)	1	5	1		2	2	3		14
TOTAL	13	22	14	16	22	15	29	11	141*

*One individual worked in two districts.

Table 8 (Continued)

SUMMARY OF EFFORT

Average Days Per Individual

Source	District 1	2	3	4	5	6	7	8	Total
Wildlife -									
Staff				3.00	8.00	2.40	1.75	2.00	2.92
Field	12.33	12.14	6.00	9.71	6.67	7.88	8.50	4.86	8.20
Research		3.00		2.00			2.29		2.46
Admin. Serv.		1.00			1.00				1.00
Air Quality							1.00		1.00
Fisheries							1.00		1.00
Forest Mgmt.	1.50		3.00	2.00	1.00				1.50
Land Res. Prog.							2.00		2.00
Law Enforcement	1.00	1.00	1.00		1.33			1.00	1.13
Resource Recovery							1.00		1.00
Spec. Field Serv.							1.00		1.00
Waterways		1.50							1.50
U.S. Forest Serv.	2.00	1.00	1.00						1.67
Federal Programs (YACC, etc.)	5.00	3.00	4.00	5.00	1.50		1.00	1.50	3.36
Other (volunteer)	1.00	1.00	2.00		1.00	2.00	1.00		1.21
TOTAL	4.61	5.04	4.00	6.12	3.73	5.27	3.55	3.64	4.46