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Use of Age-Length Information in Scallop Assessments

By

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ABSTRACT

A method is proposed for the construction of catch-at-age matrices for use in virtual population analysis (VPA) when yearly age-length keys are not available. The method is tested, first on a model population using Westrheim's and Ricker's (1978) data, then on haddock data for which yearly age-length keys are available. It is then applied to Georges Bank scallop data. The method produces improved results using the same basic data and should be a useful tool when yearly age-length keys are not available as it performs better than an average age-length key.

RÉSUMÉ

Une méthode est proposée pour la construction de matrices prises-âge destinées aux analyses de populations virtuelles (APV) lorsque des tables annuelles de correspondances âge-longueur ne sont pas disponibles. La méthode est éprouvée d'abord sur une population modèle avec les données de Westrheim et Richer (1978), puis avec des données sur l'aiglefin pour lesquelles il existe des tables annuelles de correspondances âge-longueur. Elle est ensuite appliquée aux données sur le pétoncle du Banc de George. Elle donne de meilleurs résultats avec les mêmes données de base et devrait être utile lorsqu'il n'existe pas de tables annuelles de correspondances âge-longueur, car elle donne de meilleurs résultats qu'une table de valeurs moyennes.

INTRODUCTION

When performing a virtual population analysis (VPA) on any commercially exploited species, the accuracy of the results is largely dependent on the accuracy of the catch-at-age matrix that is used. It is generally acknowledged that the best method of producing a catch-at-age matrix is by using aged subsamples of the catch to produce a yearly age-length key. It is of course expensive and time consuming to age a sample large enough to give adequate coverage, and the results are dependent on the accuracy of the ageing technique used. In many species, and scallops are no exception, ageing has turned out to be a very subjective process. Table 1 shows various published estimates of the parameters for a von Bertalanffy growth curve fitted to aged samples of Placopecten magellanicus from Georges Bank.

Besides the degree of subjectivity involved in the reading of annual rings on the scallop shells, a process that is not helped by the fact that anything that greatly disturbs the scallop appears to cause the formation of a "shock ring;" there is another source of bias in ageing scallop shells. This is the convention used to assign a birth date for scallops and an age to the first annulus.

It is generally accepted that Georges Bank scallops are born in October and the first annulus is laid down the following spring, in March or April. This ring is approximately 10 mm from the umbo, but it tends to wear off as the animal grows and thus becomes difficult to see. Because of this, the ring laid down the following spring is often referred to as the first ring (see Naidu 1970 and Posgay 1979). The convention used here is that the ring laid down in the first spring of life will be called the first annulus. As is a common convention in finfish research, the scallops are assigned a birth date of January 1 of the year in which they were born. This differs from the convention used by American scallop researchers who assign a birth date of October 1 of the year in which they were born (Posgay 1959; Serchuk et al. 1982). Thus, on the March 1 following its birth, a scallop is said to be 15 mo old by our convention, and 5 mo old by the American convention.

When fitting growth curves to size and age data the method used here is that of K.R. Allen (1965) for fitting a von Bertalanffy growth curve. This is a least-squares method which gives equal weight to each data point. Since the annuli used in determining the age of a scallop shell are laid down on the shell margin, one is able to determine the shell height of an individual in the spring of each year of its life. This enables a single shell to contribute more than one point to the data to be fitted, and more important, gives points for the earlier rings when small scallops are not sampled. The results produced by using all rings and that of using only the final ring differ. Table 2 shows the parameters and expected sizes at ring formation of a von Bertalanffy curve fitted to ring size of 1,193 scallop shells taken from Georges Bank in August 1983. A comparison of the results obtained when using all rings seen (no first annuli were observed) and when using only the final ring, show large differences in the parameters L_∞ and K. These differences, however, tend to cancel each other out, resulting in similar sizes at ring formation, with the exception of the second ring (the first ring was omitted because it is not generally measurable).

Since it is the parameter K that determines the steepness of the curve and is therefore related to the growth rate, using all the rings results in a slower predicted rate of growth. This is an indication that there is some form of "Rosa Lee's Phenomenon" (Lee 1912; Ricker 1975) acting on the sampled population. If this is the case, then using all rings biases the fit of the curve because more points are contributed by the older, presumably slower growing, individuals.

Because of this, it was felt that it would be better to have each individual contribute equally to the fit of the curve. However, since the predicted size at ring formation for the second ring was too low when using only the final ring, presumably due to the lack of data points in this region, it was decided to try fitting the curve using data points for both the second ring and the final ring. This would force the curve through the second ring size and still give equal weight to each individual (there were no shells with less than 2 rings). The results seen in Table 2 show that the predicted sizes are similar to those obtained when using only the final ring, with the exception of the predicted size of the second ring.

With the problems and cost inherent in producing an annual age-length key for each population of scallops, and the lack of a series of annual keys covering a time period long enough to use VPA techniques, alternate methods of producing a catch-at-age matrix were looked at. In the 1983 Georges Bank scallop stock assessment (Mohn et al. 1984), numbers-at-weight were converted to numbers-at-age by applying an inversion of the growth curve and assigning an age to each weight class, using a linear interpolation for the division of the numbers in a weight interval that spanned two ages. It was felt, however, that this method contained a similar bias to that reported by Westrheim and Ricker (1978) as occurring when the age-length key from one year is applied to the catch from another year.

If it is assumed that the source of bias is the variance in year-class strength and if the relative year-class strengths are known, an alternative to an annual age-length key is to apply a correction factor for the relative year-class strengths. This method does not attempt to correct for density or time-dependent variations in growth rate.

In a previous scallop assessment (Mohn et al. 1984) catch-at-age was estimated by inverting the von Bertalanffy length as a function of age. This gave an "age" for each length or more accurately for each weight. Thus, the length (weight) frequency could be converted into catch-at-age data. This method we will call the single age-length key or, more accurately, inverse growth curve method. The purpose of this study is to develop a more accurate catch-at-age.

Test on Model Population

If it is assumed the size at age of a population approximates a series of normal distributions, then if the mean and standard deviation for the distribution of size at each age is known or can be estimated, the percentage distribution of size for each age can also be calculated. Since an age-length key uses percent distribution of ages in each size class, then factors for relative survival-at-age and relative year-class strength can be used to construct an age-length key from a table of size-at-age distributions or to correct a key constructed from one year's data to apply to another year. As a test, the data from Westrheim and Ricker (1978), which were used to show how a bias occurs, have been used to show how to correct for this bias. Table 3 (Westrheim's and Ricker's Table 2a) shows a completely representative sample of a model population in which both survival and growth remain unchanged from year to year, the fish were always accurately aged, and there was no sampling error. From this parental sample we extracted the information in Table 4.

Since the distribution of size-at-age approximates a normal distribution, then:

$\int_i^j (\sigma\sqrt{2\Pi})^{-1} \exp(-(y-\mu_a)^2/2\sigma_a)\, dy$ is the percentage of individuals of age "a" that is in the size range "i" to "j". Therefore, a table showing distribution of each age into size classes according to a normal distribution can be constructed (Table 5).

These values can then be multiplied by the values (given in Table 4) for relative survival-at-age, and by the relative year-class strengths of the filial population to which the key will be applied. In the example given in Westrheim and Ricker (1978) the year-class strengths were simply rotated one age class to the right, simulating the transition from one year to the next. The resulting relative distribution table is shown as Table 6, and the calculated age-length key in Table 7. This key is then applied to the totals column from Table 8 (Westrheim's and Ricker's Table 3), and the actual and computed filial distributions in Tables 8 and 9 are compared. The survival at age is a single estimate for the entire period based on catch analysis.

The slight differences between the actual and computed age-length matrices are a fraction of a percent. With data for size-at-age, relative survival, and year-class strength, it is then possible, at least in theory, to construct an artificial age-length key that gives accurate results.

Test on Actual Population Data

This method was tested on NAFO Area 4X haddock data. This data set was selected because it covered a long period (1971 to 1983), the accuracy of the ageing of haddock samples was felt to be better than that of most species (R. O'Boyle,[1] pers. comm.), and numerous aged samples were taken from these data and frequent age-length keys produced.

The haddock data used for this test is the first quarter, 4X commercial otter trawl fishery, from 1971 to 1983 for the age-length keys, and 1977 to 1982 for the length frequencies. The data on year-class strengths and relative survival were calculated from the numbers at-age estimated by cohort analysis in O'Boyle et al. 1983. Relative survival at age was the average for 1971 to 1983. The data for aged samples from all years were combined to calculate standard deviations and size-at-age as predicted from the fit of a von Bertalanffy growth curve to these data.

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[1] R. O'Boyle, Marine Fish Division, Dept. of Fisheries and Oceans, Scotia-Fundy Region, Dartmouth, N.S.

A comparison of the catch-at-age tables produced by this method and that produced by using the real age-length keys do show differences (Table 10a and b). The result of using the constructed keys is a smoother distribution of catch-at-age, with more fish ending up in the older age classes. Fish over 11 yr old usually make up less than 0.2% of the population. With the numbers of fish being sampled for age analysis (averaging 475 per year from 1971 to 1983), it is unlikely that a year-class that makes up such a small part of the population will be represented in the sample used to construct the age-length key. This shows up in the catch-at-age matrix produced by the actual age-length keys, as fish over 11 yr old are often not represented at all. This creates inconsistencies in the matrix, with a year-class disappearing and then reappearing in a subsequent year's catch, as happens with the year-class that makes up the 14 yr olds in the 1980 catch. This is also indicated by the fact that the year that showed the least catch of older fish, 1982, was based on a key constructed from the smallest aged sample (232 fish).

A combined catch-at-age matrix was used for analysis of the 4X otter trawl catch would be based on samples taken throughout the year. This larger total sample size would be expected to be a better representation of the age structure of the catch; however, the biologists involved in the analysis of the haddock fishery feel that the older aged fish are still underrepresented in the final catch-at-age matrix and are presently looking at ways to correct this problem (R. O'Boyle, pers. comm.). This would support the validity of the age structure resulting from using the constructed keys.

As a comparison with the method of an inverse growth curve generated key as was used in the 1983 Georges Bank scallop stock assessment (Mohn et al. 1984), a single key constructed in the same method was applied to the haddock data (Table 11). The most obvious effect is the shifting of large numbers of animals into the older age classes. This effect was much greater than that found with the scallop data. This is due to the use of a linear interpolation and the greater overlap in size-at-age for the older age classes in the haddock data. One length interval in the size frequency distribution may contain as many as four ages, which may be compared to the case of the scallop data where a size frequency interval would contain, at most, two ages. The use of a more realistic relationship to divide the numbers in a size interval into age classes would be an improvement. However, when the relative distribution of the first seven ages is examined (Table 12), it shows that the peak in numbers-at-age when using this method always occurs at 4 yr old. This differs from either the matrix produced by the constructed keys or that from the actual keys, where the peak shifts between 4 yr olds and 5 yr olds with variations in year-class size. These results indicate that the use of the constructed keys is a more accurate method of producing a catch-at-age matrix than the use of a single key.

Application to Scallop Data

In order to assess the magnitude of the correction in this method as compared to a single key, the numbers at age 3 from the cohort analysis in the 1983 scallop stock assessment were compared with age 3 numbers produced with the use of the constructed keys. Standard deviations of size-at-age are from the 1983 Georges Bank samples discussed earlier; the mean size at age is that predicted from the von Bertalanffy fit to the second and final annuli on the shells. The units in length were converted to weights, adjusted to January 1, and catches were used as a rough indication of the year-class strength of 3 yr olds. The resulting age 3 numbers-at-age are:

Age 3 population numbers and relative frequency.

	1972	1973	1974	1975	1976	1977
Inverse Growth Numbers	662	780	1,259	1,452	1,213	798
Relative Frequency	46	54	87	100	84	55
Reconstructed Numbers	710	885	1,199	1,551	1,481	822
Relative Frequency	46	57	77	100	95	53
Percent Change	7	13	-5	7	22	3

	1978	1979	1980	1981	1982	1983
Inverse Growth Numbers	609	866	1,129	337	159	120
Relative Frequency	42	60	78	23	11	8
Reconstructed Numbers	571	849	1,024	312	112	210
Relative Frequency	37	55	66	20	7	14
Percent Change	-6	-2	-9	-7	-30	75

There are some large changes in the size of the resulting year-class, especially in the size of the 3 yr olds in 1983. There is a 75% increase in the predicted numbers-at-age, also changes in the 1976 and 1982 numbers, but in 8 out of 12 yr the changes are less than 10%.

CONCLUSION

In conclusion, it appears that the use of age-length keys constructed from growth data produces reasonably accurate results when they are enhanced with estimates of year-class strength and relative survival. Although not a replacement for annual age-length keys produced by ageing samples from the catch, this method appears to be useful when that type of information is not available. The use of cohort results in the haddock tests is not completely valid as the numbers result from previous cohort analysis using age-length keys. But this method does not depend on cohort output but rather any source of numbers-at-length. The source could be research data or commercial sampling. The most important factor is that age classes be identifiable in the length frequency data. The second requirement is for estimates of suvivorship which generally would be obtained from catch curve analysis or from the early portion of a cohort analysis.

It is acknowledged that a degree of circularity or underdetermination is inherent in our approach. In order to get catch-at-age one needs survivorship; in order to get survivorship one needs catch-at-age in some form. It would be best if a few aged samples were available (obviously at least one is needed), and then the constructed keys could either interpolate among them or be based on their average. The choice for the actual strategy will depend on the data and general rules cannot be suggested at this time.

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Table 1a. von Bertalanffy growth parameters for Placopecten magellanicus.

Source		L_∞	K	T_0	N	Area
1a Posgay	1959	146.5	0.30	1.32	426	NE Peak G.B.
1b Posgay	1959	141.8	0.28	1.00	254	N Edge G.B.
2 Posgay	1962	148.9	0.26	1.0	NK	Georges Bank
3 Brown et al.	1972	145.5	0.38	1.5	NK	Georges Bank
4 Posgay	1976	146.4	0.35	1.4	7000	Georges Bank
5 Posgay	1979	143.6	0.37	1.0	7000	Georges Bank
6 Serchuk et al.	1982	152.46	0.3374	1.4544	NK	Georges Bank

Table 1b. Size at age from parameters in Table 1a.

	Age							
Source	2	3	4	5	6	7	8	9
1a	27	58	81	98	111	120	127	132
1b	35	61	81	96	107	115	122	127
2	34	60	81	96	108	118	125	130
3	25	63	89	107	119	128	133	137
4	28	63	87	105	117	126	132	136
5	44	75	96	111	121	128	133	136
6	26	62	88	106	120	129	136	141

Table 2. von Bertalanffy growth parameters.

Rings used for fit	L_∞	K	T_o
All	161.38	0.1783	1.1951
Final only	131.62	0.3030	1.6517
Final + second	139.31	0.2451	1.2680

Predicted size at ring formation with different methods (mm).

	Age							
Rings used	2	3	4	5	6	7	8	9
All	22	44	64	79	93	104	113	121
Final only	13	44	67	84	96	106	112	117
Final + second	23	48	68	83	96	105	113	118

Table 3. Age-length matrix of a population in which year-class strength varies in the ratio 2:1, and rate of increase in length decreases with age. (For simplicity, there is no growth between ages 8 and 9, or between ages 10 and 11.) (from Westrheim and Ricker 1978)

Age	4	5	6	7	8	9	10	11	Total
Strength	2	1	1	2	1	1	2	1	
				A. Parental distribution					
Length (cm)									
	6								6
40	61								61
	242								242
50	383								383
	242	2							244
60	61	23							84
	6	91							97
70		144	2						146
		91	17						108
80		23	68	3					94
		2	108	26	1				137
90			68	102	10	5			185
			17	162	38	19	3		239
100			2	102	61	30	11	1	207
				26	38	19	18	1	102
110				3	10	5	11	1	30
					1	0	3	0	4
Total	1001	376	282	424	159	78	46	3	2,369
%	42.2	15.9	11.9	17.9	6.7	3.3	1.9	0.1	

Table 4. Information derived from parental sample, Table 3.

Age	Mean Length (cm)	Standard Deviation	Relative Survival	Relative Year-class strength
4	50	4.99	1	2
5	70	4.97	.7512	1
6	85	5.03	.5634	1
7	95	5.05	.4236	2
8	100	5.04	.3177	1
9	100	4.82	.1588	1
10	105	4.84	.0460	2
11	105	4.79	.0060	1

Table 5. Distribution of each age in size-classes according to normal distribution (cut off point = .9995) using means and standard deviations from Table 4.

Size Class/Age	4	5	6	7	8	9	10	11
35	.0060							
40	.0606							
45	.2417							
50	.3830							
55	.2417	.0057						
60	.0606	.0596						
65	.0060	.2430						
70		.3830	.0064					
75		.2430	.0617					
80		.0596	.2404	.0064	.0002			
85		.0057	.3830	.0615	.0063	.0047		
90			.2404	.2404	.0615	.0546	.0044	.0047
95			.0617	.3830	.2404	.2421	.0537	.0569
100			.0064	.2404	.3830	.3970	.2433	.2397
105				.0615	.2404	.2421	.3970	.3970
110				.0064	.0615	.0546	.2433	.2397
115					.0063	.0047	.0537	.0569

Table 6. Relative distribution of ages within each size class (Table 5 adjusted, for relative survival from Table 4 and relative year-class strength from Table 8)

Size Class/Age	4	5	6	7	8	9	10	11	Total
35	.0060								.0060
40	.0606								.0606
45	.2417								.2417
50	.3830								.3830
55	.2417	.0086							.2503
60	.0606	.0895							.1501
65	.0060	.3651							.3711
70		.5755	.0036						.5791
75		.3651	.0348						.3999
80		.0895	.1354	.0027	.0001				.2277
85		.0086	.2158	.0261	.0040	.0007			.2552
90			.1354	.1018	.0391	.0085	.0002	.0001	.2851
95			.0348	.1622	.1528	.0377	.0025	.0007	.3907
100			.0036	.1018	.2434	.0619	.0112	.0029	.4248
105				.0261	.1528	.0377	.0183	.0048	.2397
110				.0027	.0391	.0085	.0112	.0029	.0644
115					.0040	.0007	.0025	.0007	.0079

Table 7. Calculated age-length key

Size Class/Age	4	5	6	7	8	9	10	11	Total
35	100								100
40	100								100
45	100								100
50	100								100
55	96.56	3.44							100.00
60	40.37	59.63							100.00
65	1.62	98.38							100.00
70		99.38	00.62						100.00
75		91.30	8.70						100.00
80		39.31	59.46	1.19	0.04				100.00
85		3.37	84.56	10.23	1.57	0.27			100.00
90			47.49	35.71	13.71	2.98	0.07	0.04	100.00
95			8.91	41.52	39.11	9.65	0.64	0.18	100.01
100			0.85	23.96	57.30	14.57	2.64	0.68	100.00
105				10.89	63.75	15.73	7.63	2.00	100.00
110				4.19	60.71	13.20	17.39	4.50	99.99
115					50.63	8.86	31.65	8.86	100.00

Table 8. A, Age-length matrix like that of Table 3, except that the year-class strengths are shifted 1 yr to the right. (from Westrheim and Ricker 1978)

Age Strength	4 1	5 2	6 1	7 1	8 2	9 1	10 1	11 2	Total
				A. Actual filial distribution					
Length (cm)									
	3								3
40	30								30
	121								121
50	192								192
	121	4							125
60	30	46							76
	3	182							185
70		287	2						289
		182	17						199
80		46	68	1					115
		4	108	13	2				127
90			68	51	19	5			143
			17	81	77	19	1		195
100			2	51	121	30	6	1	211
				13	77	19	9	2	120
110				1	19	5	6	1	32
					2	0	1	0	3
Total	500	751	282	211	317	78	23	4	2,166
%	23.1	34.7	13.0	9.7	14.6	3.6	1.1	0.2	

Table 9. Age-length matrix computed from the totals column of Table 8 and the age-length key in Table 7.

Size Class/Age	4	5	6	7	8	9	10	11	Total
				B. Computed filial distribution					
Length (cm)									
35	3								3
40	30								30
45	121								121
50	192								192
55	121	4							125
60	31	45							76
65	3	182							185
70		287	2						289
75		182	17						199
80		45	68	1	0				114
85		4	107	13	2	0			126
90			68	51	20	4	0	0	143
95			17	81	76	19	1	0	194
100			2	51	121	31	6	1	212
105				13	77	19	9	2	120
110				1	19	4	6	1	31
115					2	0	1	0	3
Total	501	749	281	211	317	77	23	4	2,163
%	23.2	34.6	13.0	9.8	14.7	3.6	1.1	0.2	100.02

Table 10a. Catch at-age using artificial keys

Age	1977	1978	1979	1980	1981	1982
1	0	0	0	0	0	0
2	2,426	548	1,690	555	1,029	299
3	83,676	53,100	49,644	19,773	15,713	7,899
4	111,010	100,537	171,014	40,352	51,074	10,117
5	210,176	40,022	101,464	66,696	20,495	16,667
6	156,081	40,374	27,623	34,328	19,478	4,965
7	13,135	23,648	24,737	9,398	8,330	4,325
8	29,022	2,075	13,478	8,621	2,250	1,904
9	8,952	4,453	930	4,702	2,076	485
10	2,679	1,401	1,828	335	1,157	451
11	2,949	392	497	633	78	236
12	857	410	129	174	146	16
13	651	123	137	46	41	30
14	3,670	106	46	57	11	8

Table 10b. Catch-at-age using actual keys

Age	1977	1978	1979	1980	1981	1982
1	0	0	0	0	0	0
2	905	0	0	0	138	33
3	71,807	45,837	22,725	8,145	6,219	4,734
4	91,163	129,411	212,955	35,400	42,683	9,227
5	231,539	28,674	109,110	80,737	36,021	21,512
6	175,635	37,729	23,214	46,470	24,622	6,519
7	17,936	20,901	17,985	9,113	8,884	4,528
8	25,122	3,544	6,037	3,745	1,286	392
9	3,159	936	501	1,841	1,282	290
10	2,068	42	360	48	524	115
11	1,516	68	116	29	51	51
12	534	0	0	20	95	0
13	953	46	0	18	36	0
14	2,944	0	50	56	38	0
15	0	0	0	18	0	0
16	0	0	164	21	0	0

Table 11. Catch-at-age using a single key.

	1977	1978	1979	1980	1981	1982
1	42	0	0	0	138	0
2	24,759	16,215	14,832	5,339	6,028	2,717
3	106,182	77,127	120,927	31,892	35,669	8,985
4	165,675	83,437	134,777	56,230	37,378	16,640
5	155,651	41,298	66,353	45,610	20,567	9,211
6	81,224	20,733	29,387	23,382	9,865	4,443
7	34,036	11,017	11,437	9,496	4,868	2,258
8	15,312	4,674	4,444	4,680	1,910	830
9	10,077	2,872	2,839	2,561	1,291	495
10	5,466	1,284	1,438	1,595	755	202
11	5,466	1,284	1,438	1,595	755	202
12	5,779	1,802	1,464	1,294	738	340
13	3,903	1,361	970	746	479	270
14	3,903	1,361	970	746	479	270
15	3,903	1,361	970	746	479	270
16	3,903	1,361	970	746	479	270

Table 12. Relative frequencies, ages 1 to 7, of catch-at-age matrices formed using different techniques.

12a Catch at age from artifical keys

Age	1977	1978	1979	1980	1981	1982
1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.0042	0.0021	0.0045	0.0032	0.0089	0.0068
3	0.1451	0.2056	0.1320	0.1156	0.1353	0.1784
4	0.1926	0.3893	0.4546	0.2358	0.4398	0.2285
5	0.3646	0.1150	0.2597	0.3898	0.1765	0.3765
6	0.2707	0.1564	0.0734	0.2006	0.1677	0.1122
7	0.0228	0.0916	0.0658	0.0549	0.0717	0.0977

12b Catch at age from actual age length keys

Age	1977	1978	1979	1980	1981	1982
1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.0015	0.0000	0.0000	0.0000	0.0012	0.0007
3	0.1219	0.1746	0.0589	0.0453	0.0525	0.1017
4	0.1548	0.4929	0.5517	0.1968	0.3600	0.1982
5	0.3931	0.1092	0.2827	0.4489	0.3038	0.4621
6	0.2982	0.1437	0.0601	0.2584	0.2077	0.1400
7	0.0305	0.0796	0.0466	0.0507	0.0749	0.0973

12c Catch at age from single key

Age	1977	1978	1979	1980	1981	1982
1	0.0001	0.0000	0.0000	0.0000	0.0012	0.0000
2	0.0436	0.0649	0.0393	0.0310	0.0526	0.0614
3	0.1871	0.3087	0.3202	0.1855	0.3115	0.2030
4	0.2919	0.3340	0.3568	0.3270	0.3264	0.3760
5	0.2742	0.1653	0.1757	0.2653	0.1796	0.2081
6	0.1431	0.0830	0.0778	0.1360	0.0861	0.1004
7	0.0600	0.0441	0.0303	0.0552	0.0425	0.0510