

THE EFFECTS OF NUMBERS OF MARK-RECAPTURE OBSERVATIONS ON COEFFICIENTS OF VARIATIONS OF FLEET SIZE ESTIMATES

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SUMMARY

The U.S. National Marine Fisheries Service and cooperating organizations have conducted annual surveys of the rod and reel fishery for large pelagic fish off the northeast coast since 1985. The survey uses area-specific estimates of fleet size derived using mark-recapture techniques. The effects of different sampling levels on coefficients of variation for estimates of fleet size were examined using bootstrap techniques. Results varied with area and were dependent on the number of boats identified, the number of boats considered marked, and the assumed true fleet size. Coefficients of variation of 10 percent were possible for some areas, but not others.

RESUME

Depuis 1985, le National Marine Fisheries Service et les organisations de coopération effectuent des prospections annuelles sur la pêcherie à la canne et au moulinet des grands pélagiques, au large de la côte nord-est. La prospection utilise des estimations spécifiques de zone de l'ampleur de la flottille, dérivées en utilisant des techniques de marquage-recapture. Les effets de différents niveaux d'échantillonnage sur les coefficients de variation des estimations de l'ampleur de la flottille ont été examinés en utilisant des techniques itératives. Les résultats variaient selon la zone et dépendaient du nombre de bateaux identifiés, le nombre de bateaux considérés marqués, et la vraie grandeur postulée de la flottille. Les coefficients de variation de 10% étaient possibles pour certaines zones mais pas pour d'autres.

RESUMEN

Desde 1985, el "U. S. National Marine Fisheries Service" y organizaciones cooperativas, han llevado a cabo prospecciones anuales de la pesquería de caña-carrete para grandes peces pelágicos frente a la costa nordeste desde 1985. En la prospección se utilizan estimaciones específicas de área del tamaño de la flota, obtenidas empleando técnicas de marcado-recaptura. Se examinaron los efectos de los diferentes niveles de muestreo sobre los coeficientes de variación para las estimaciones del tamaño de la flota, empleando técnicas de ensayos iterativos de reajuste a partir de submuestras ("bootstrap"). Los resultados variaban según el área, y dependían del número de barcos identificados, del número de barcos que se consideraban marcados, y del verdadero tamaño asumido de la flota. Los coeficientes de variación del 10% eran posibles para algunas áreas, pero no para otras.

INTRODUCTION

The Large Pelagic Survey (LPS) relies on estimates of fleet size in the calculations of catch for VA-MA (Virginia to Massachusetts). Those estimates are obtained through mark-recapture techniques. The purpose of this paper is to provide information useful for determining mark-recapture sampling levels sufficient for obtaining fleet size estimates with a given degree of precision.

Coefficients of variation about area specific fleet size estimates were calculated to examine the effects on those estimates of different numbers of unique boats identified through mark-recapture sampling. The results of these analyses could be used to select sampling levels for each area under an assumption about the number of unique boats observed per sampling assignment.

METHODS

The 1992 mark-recapture sampling in VA conducted by KCA Research under contract with the National Marine Fisheries Service at randomly assigned sites have been used by the Atlantic Bluefin Tuna Catch Estimation Review Panel to estimate the private boat fleet size for use in catch estimation. The procedures in handling mark-recapture data are described in Porch (SCRS/92/137) and the methods of estimation of the catch are described in Brown (SCRS/92/131). The sampling through 2 July (Panel report 7 of 22 July, document ABTS/92-7/2) resulted in estimates of the total VA fleet size (private plus charter) which ranged from 1,865 to 2,515 depending on the treatment of the data. Those estimates were roughly 180% and 245% of the estimate of 1032 boats used for 1991 (ABTS/92-3/8). In the catch estimation, 1000 bootstrap estimates of private boat fleet sizes were made by estimating the entire fleet and subtracting the assumed number of charter boats (97). For the VA mark-recapture data through 12 July, the mean of the estimates was 1784 private boats (median of 1768) with a coefficient of variation of 9.75.

Bootstrap techniques were used to obtain 1000 estimates of fleet size at each of 10 sampling levels for each area. The analyses were conducted using the initial 1992 LPS telephone lists for each state as the list of marked boats, assuming no duplicate entries were present. Three sets of analyses were made; one assumed that the marked boats represented the same proportion of the true fleet size in each area as was observed in data used for

the previous year, and the second and third analyses assumed that the proportion of marked boats in the true fleet was half and a third of that level (ie the fleet was 2 times and 3 times larger than estimate used for 1991). For MDDE (Maryland-Delaware) the proportion of the marked boats in the estimated fleet was available only by state (15% and 17%, respectively), so an average of 16% was used.

Within each of the three sets of runs results were tallied for each area at numbers of unique boats identified either from 50 to 500 or from 100 to 1000, depending on the coefficient of variation (CV) at 500. If a CV of about 10% was not obtained within the 50 to 500 boat analyses, then results were presented for 100 to 1000 boats.

#### RESULTS AND DISCUSSION

The coefficients of variations of about 10% were estimated for all areas under the assumption that the 1992 marked list represented a similar proportion of the fleet used for 1991. For NJ, NY and CTRI that precision could be obtained with up to 250 unique names (Table 1). For MDDE and MA between 300 and 500 unique names would be needed. The relationship between CV and the number of unique names needed to obtain the same precision at different fleet sizes for an area was not linear; for a fleet size 3 times the previous estimate, 3.5-5 times as many unique names were needed to obtain CV's of about 10% (Tables 1 and 3).

#### Number of Assignments

In VA mark-recapture sampling, increasing numbers of unique names per sampling assignment were observed. From 1 June through 26 July the average number of unique boats per assignment was 2.6 boats (ABTS/92-7/2 and ABTS/92-3/1). The number of trips per private boat increased from 0.15 per week from June 1-14 to 0.4 per week through 12 July (ABTS/92-7/1). Assuming that private boats have remained as active through 26 July, the 15 June - 26 July average of 3.2 boats per assignment may be closer to levels which might be achieved during late July and August in MDDE to MA when private boats are probably most active.

At 3.2 unique boats per assignment, 31 assignments would be needed to obtain 100 unique names in field sampling.

#### Number of Marked Boats

The precision of estimates of fleet size depend both on the number of vessels marked and the number of unique names examined for marks (contacted in sampling). An alternative way of increasing the precision of estimates of fleet size would be to increase the number of marked boats. Obtaining more marked boats from existing mailing and permit lists could be cost effective ways of increasing the precision of the estimates, especially for MDDE, CTRI and MA for which the marked lists are small. Table 1 shows the estimated CV's derived when those proportions are 16%, 33% and 24% respectively, while Table 3 is based on proportions of 5%, 11% and 8% respectively.

Unique Names	Coefficient of Variation					
	VA	MDDE	NJ	NY	CTRI MA	
50	14.1	55.0	15.5	18.3	24.2	29.3
100	10.0	25.9	10.8	12.0	15.1	18.5
150	8.2	21.0	8.8	9.9	12.7	15.1
200	7.0	17.1	7.7	8.7	10.7	13.1
250	6.3	14.9	6.9	7.6	9.3	11.5
300	5.7	13.9	6.1	6.7	8.4	10.7
350	5.3	12.6	5.8	6.3	7.7	9.6
400	5.0	11.8	5.4	5.8	7.3	9.1
450	4.5	11.1	4.9	5.5	7.0	8.5
500	4.3	10.5	4.7	5.2	6.4	8.2
Marked Lists:	499	104	587	794	211	191
Mean Fleets:	961	657	1225	1828	642	801

Table 1. Coefficients of variation (in percent) of 1000 estimates of fleet size in each area at 10 levels of unique names obtained through sampling, the mean estimate of fleet size at the highest sampling level, and the number of boats on the marked list. These analyses were conducted under the assumption that the fleet size was equal to the estimate used for 1991.

Table 2. Coefficients of variation (in percent) of 1000 estimates of fleet size in each area at 10 levels of unique names obtained through sampling, the mean estimate of fleet size at the highest sampling level, and the number of boats on the marked list. These analyses were conducted under the assumption that the fleet size was twice the size as used for 1991.

	Unique Names	VA	NJ	NY	CTRI		Unique Names	MDDE	MA
Marked List:		499	587	784	211			104	191
Mean Fleet:		1930	2461	3673	1292			1313	1601
		Coefficient of Variation						CV	
	50	28.5	31.9	36.8	56.5		100	48.9	32.7
	100	18.5	19.2	21.5	24.4		200	28.1	21.5
	150	14.9	15.6	16.6	20.4		300	20.7	16.6
	200	12.6	13.1	14.5	16.9		400	18.0	14.3
	250	10.8	11.5	12.4	14.5		500	16.3	12.5
	300	10.0	10.4	11.6	13.1		600	14.1	11.0
	350	9.4	9.7	10.5	11.9		700	12.9	10.2
	400	8.8	9.1	9.8	11.5		800	12.6	9.7
	450	7.9	8.3	9.3	10.5		900	10.5	9.1
	500	7.6	7.9	8.6	10.0		1000	10.4	8.4

Table 3. Coefficients of variation (in percent) of 1000 estimates of fleet size in each area at 10 levels of unique names obtained through sampling, the mean estimate of fleet size at the highest sampling level, and the number of boats on the marked list. These analyses were conducted under the assumption that the fleet size was three times the estimate used for 1991.

	Unique Names	VA	NJ		Unique Names	MDDE	NY	CTRI	MA
Marked List:		499	587			104	784	211	191
Mean Fleet:		2936	3744			1998	5556	1952	2436
		CV				Coefficient of Variation			
	50	42.7	43.9		100	68.0	29.5	35.9	53.9
	100	25.6	28.2		200	38.2	18.7	22.1	26.6
	150	19.5	21.1		300	26.5	14.7	17.9	21.4
	200	16.2	17.5		400	23.5	12.6	15.2	17.6
	250	14.5	15.5		500	19.5	11.4	12.9	15.5
	300	12.9	13.6		600	17.9	10.2	12.0	14.9
	350	12.1	12.4		700	15.3	9.3	10.9	12.9
	400	11.2	12.1		800	13.5	8.8	10.0	11.6
	450	10.3	11.7		900	13.1	7.9	9.6	11.0
	500	9.9	10.2		1000	12.1	7.7	8.9	10.3