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CURRENT UNDERSTANDING OF THE STATUS OF SMALL CETACEAN POPULATIONS IN THE BLACK SEA

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Abstract

A fishery using guns and nets for the common dolphin, *Delphinus delphis*, Azov dolphin, *Phocoena phocoena*, and bottlenose dolphin, *Tursiops truncatus*, in the Black and Azov Seas has been pursued since about 1870 from the USSR, Turkey, Bulgaria and Romania. Steadily declining annual Soviet harvests since the maximum Soviet catch of 135 000-140 000 animals in 1938, despite an increased catching effort, led to seasonal management restrictions by the USSR in 1962, and a complete closure of the fishery in the USSR, Romania and Bulgaria in 1967. The final annual Soviet catches of 5 600-7 400 animals reported for 1964-66 represent a major collapse of the fishery and were accompanied by apparent marked changes in the age and sex composition of the harvest and a change in the species composition from the historically predominant *D. delphis* to predominantly *P. phocoena*. The fishery continues in Turkey with recent reported annual catches approaching the 1938 Soviet maximum; the loss rate is estimated to be high because of the use of guns as the harvesting method.

Limited catch statistics are available since 1927, except for Romania, and are generally reported only for all species combined in total metric weight. Analysis indicates that the exploitation rate was probably excessive at the height of the fishery in 1936 (12.5-20.0 %) and may remain so today for the Turkish fishery (7.9-100.8 %).

Annual Soviet aerial surveys initiated since the 1967 moratorium provide questionable estimates of total population size of Black Sea porpoises. Problems with these estimates and probably also with kill estimates preclude definite understanding of the present state of the population and indicate the need to refine both these statistics. Present observations are confined to recognition that the numbers of porpoise in the Black Sea have declined substantially to marginal levels due to the direct fishery; the present Turkish fishery is important, particularly as it continues now when stocks are probably reduced.

Résumé

Le dauphin commun, *Delphinus delphis*, le "dauphin" de la mer d'Azov, *Phocoena phocoena*, et le souffleur, *Tursiops truncatus*, sont pêchés aux armes à feu et au filet depuis 1870 environ dans la mer Noire et la mer d'Azov par l'URSS, la Turquie, la Bulgarie et la Roumanie. La diminution régulière des captures de l'URSS depuis le maximum soviétique de 135 000-140 000 animaux en 1938, malgré un effort de capture accru, a amené ce pays à adopter des restrictions saisonnières en 1962. La pêche a été entièrement arrêtée par l'URSS, la Roumanie et la Bulgarie en 1967. Le chiffre annuel des dernières captures soviétiques en 1964-66, 5 600-7 400 animaux, représente un effondrement majeur de la pêche, qui s'est accompagné de changements nettement marqués de la composition des captures par âge et par sexe. La composition par espèce était également modifiée, *D. delphis*, qui avait toujours été l'espèce dominante, cédant la place à *P. phocoena*. La pêche se poursuit en Turquie; les

captures annuelles récentes signalées avoisineraient le record soviétique de 1938. On estime que le taux de perte est élevé par suite de l'emploi des armes à feu comme méthode d'exploitation.

On possède des statistiques de capture limitées depuis 1927, sauf pour la Roumanie. Elles donnent en général le poids total pour l'ensemble des espèces. L'analyse indique que le taux d'exploitation a été probablement excessif lors de l'apogée de la pêche en 1936 (12,5-20 %) et qu'il peut l'être encore dans la pêcherie turque (7,9-100,8 %).

Les enquêtes aériennes annuelles entreprises par les Soviétiques depuis le moratoire de 1967 fournissent des estimations d'une fiabilité contestable sur la taille totale des populations de marsouins de la mer Noire. L'incertitude de ces estimations et probablement aussi des estimations de la mortalité par pêche ne permet pas de connaître exactement l'état actuel de la population et prouve qu'il est nécessaire d'améliorer ces deux types de statistiques. A l'heure actuelle, on doit se borner à reconnaître que les effectifs des marsouins de la mer Noire ont subi un fléchissement substantiel et sont tombés à un niveau marginal du fait de la pêche directe. La pêche turque actuelle est d'autant plus importante qu'elle se poursuit à un moment où les stocks sont probablement réduits.

Extracto

Desde 1870, aproximadamente, la URSS, Turquía, Bulgaria y Rumania se dedican a la pesca de delfín común, *Delphinus delphis*, marsopa de Azov, *Phocoena phocoena*, y tursión, *Tursiops truncatus*, con redes y armas de fuego, en el mar Negro y el mar de Azov. La continua disminución de las capturas anuales de la Unión Soviética (a pesar del aumento del esfuerzo de captura) respecto a la cifra máxima de 135 000-140 000 animales conseguida en 1938 movió a ese país a introducir en 1962 restricciones, regulando la temporada de caza. En 1967, la URSS, Rumania y Bulgaria vedaron totalmente la captura de esos animales. Las últimas capturas anuales de la Unión Soviética (5 600-7 400 animales), correspondientes a 1964-66, reflejan el gran colapso de esa actividad y revelan notables cambios en la composición por edad y sexo de los animales capturados y en la composición por especies de las capturas, con un predominio de *P. phocoena* frente al predominio tradicional de *D. delphis*. En Turquía prosigue la explotación de esos delfínidos, con capturas que, en los últimos años, según los datos comunicados, se acercan a las cifras máximas de la Unión Soviética de 1938. Se calcula que el índice de pérdidas es elevado debido al empleo de armas de fuego.

Se dispone de estadísticas limitadas de captura desde 1927 (con exclusión de Rumania), que en general se refieren sólo al conjunto de todas las especies, indicando el peso total en unidades métricas. Los análisis realizados indican que probablemente el índice de explotación en el momento culminante de la pesquería (1936) era excesivo (12,5-20 por ciento) y tal vez siga siéndolo hoy día en Turquía (7,9-100,8 por ciento).

Los reconocimientos aéreos realizados anualmente por la Unión Soviética desde la veda de 1967 permiten hacer estimaciones, de valor cuestionable, sobre el volumen total de la población de delfines y marsopas del mar Negro; los problemas inherentes a esas estimaciones y, probablemente también, a las estimaciones de las capturas impiden conocer claramente la situación actual de las poblaciones y ponen de relieve la necesidad de mejorar ambas estadísticas. En la actualidad, lo único que se puede hacer es reconocer que el número de delfines y marsopas del mar Negro ha disminuido sustancialmente, como consecuencia de la explotación, reduciéndose a cifras marginales. Las actuales actividades pesqueras de Turquía son importantes, sobre todo porque probablemente las poblaciones han disminuido.

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Introduction

In 1962, the USSR adopted unilateral management restrictions on whaling in the international multispecies small cetacean fishery in the Black and Azov Seas, which took the form of a restriction on killing during the breeding season. In 1967, whaling by the USSR, Romania and Bulgaria was completely stopped. In Turkey whaling continues. The adoption of management restrictions by the other nations was prompted by steadily declining catches since 1939, and the catastrophic decline in catch in 1964-66.

The information available to me on this fishery comes from: Danilevsky and Tuyutyunnikov, 1968; Zemsky and Yablokov, 1974; Mitchell, in press – draft version; personal communication with Zemsky and Yablokov, December 1964, in La Jolla, California.

There are several other papers referred to in the above papers which would be valuable and copies are being sought. All of the references of which I am aware which may be directly relevant to the status of the Black Sea porpoise populations are listed in the bibliography.

History of the fishery

The catching of small cetaceans in the Black Sea apparently began circa 1870 (Zemsky and Yablokov, 1974). The earliest record I have been able to obtain is from 1927, when a catch of 9 300 animals by Soviet fishermen was reported (Zemsky and Yablokov, 1974).

The available statistics suggest a maximum Soviet catch of 135 to 140 000 animals in 1938. Subsequently, the catch apparently declined, until the whaling stopped in all countries except Turkey in 1966. Available catch statistics for the USSR, Bulgaria and Turkey are given in Table 1; the numbered notes indicate the variety of sources from which they were drawn. No information is available on the magnitude of the Romanian catch, but Jelescu (1960, quoted in Mitchell, 1974) describes the fishing techniques.

There are 3 species of small cetaceans involved in varying degrees in this fishery. These are *Delphinus delphis*, the common dolphin, *Phocoena phocoena*, the harbour porpoise, and *Tursiops truncatus*, the bottlenose dolphin. The catch statistics are generally available only for all species combined, as shown in the notes. It is known, however, that the common dolphin, *D. delphis*, has historically been predominant in the catch. Note that the catch records from the fishery have historically been reported in centners – hundred of kilogrammes. The formal English name for this quantity is quintal, and it corresponds approximately to 220 lb. The 9 300 animals figure reported for 1927 is apparently based on a conversion of one animal to approximately 54 kg (Zemsky and Yablokov, 1974). Thus the 1927 catch was probably first reported as 5 022 centners or 502.2 metric tonnes. The origin of the figure of 54 kg as the average weight of each animal in the catch statistics is unknown to me. Its accuracy depends on both the species composition and the age and sex composition of the catch. As no other conversion factors are available this has been used throughout this report.

Two methods of harvesting are used, guns and nets. The gun method apparently has a very high loss rate of wounded animals. The loss rate with the net fishery is considered small (Zemsky and Yablokov, 1974). Turkey, the only remaining country pursuing this fishery, uses the gun method (Zemsky and Yablokov, 1974).

With these points in mind, it appears that the Soviet fishery reached a peak in 1938 and then declined steadily. Thus, the average pre-war catch is listed as roughly twice that of the average post-war catch. This decline in the catch occurred despite greatly increased effort, both in quantity and quality. For instance, after the war, aerial spotting planes were

Table 1. Estimated numbers of small cetaceans killed in the Black Sea, by nation and for all nations, for all species, in thousands. Figures in parentheses indicate average catch over the time period covered by the arrows

Year	USSR	Bulgaria	Turkey	All Nations
1927	9.3 [1]			
1928				
1929				
1930				
1931				
1932	(66.) [1]			
1933				
1934				
1935				(250-300) [3]
1936				
1937				
1938	134.-140. [2]			
1939				
1940				
1941*	≈0 [18]		> 0 [19]	
1942*	≈0	1.7 [11]	> 0	
1943*	≈0		> 0	
1944*	≈0		> 0	
1945*	≈0		> 0	
1946				
1947				
1948				
1949				
1950				
1951				
1952				
1953				
1954			(157-185.2) [7]	
1955		31.0 [6]		
1956	(≈33.0) [4]			
1957				
1958				
1959				
1960			30.0-40.0 [8]	
1961	46.5 [5]			
1962	** [15]			
1963	**			
1964	**			
1965	**	(5.6-7.4) [17]		
1966	*** [14] 0.0 [16]			3.7 [13]
1967	*** 0.0	*** [17] 0.0 [17]	3.9 [9]	1.0 [13]
1968	*** 0.0	*** 0.0	37.4 [9]	
1969	*** 0.0	*** 0.0		
1970	*** 0.0	*** 0.0		

Table 1. Estimated numbers of small cetaceans killed in the Black Sea, by nation and for all nations, for all species, in thousands. Figures in parentheses indicate average catch over the time period covered by the arrows *(concluded)*

Year		USSR		Bulgaria	Turkey	All Nations
1971	***	0.0	***	0.0		
1972	***	0.0	***	0.0	35.2[9]	
1973	***	0.0	***	0.0	129.5[9]	
1974	***	0.0	***	0.0		

* Indicates war years;
** Indicates summer season fishery restriction;
*** Indicates complete fishery restriction.

[1] (Zemsky and Yablokov, 1974).
[2] (Zemsky and Yablokov, 1974) maximum catch reported.
[3] (Zemsky and Yablokov, 1974) "Summary catch of all Black Sea countries" to compare with abundance estimate for the thirties from Arseniev, Zemsky and Studenetsskaya, 1973.
[4] (Zemsky and Yablokov, 1974) "(The catch) in 1946-66 ... hardly reached half of this number" referring to 1927-38 average of 66 000 dolphins.
[5] (Zemsky and Yablokov, 1974) apparently maximum catch by USSR since war years.
[6] (Zemsky and Yablokov, 1974) maximum catch by Bulgaria.
[7] (Danilevsky and Tyutyunnikov, 1968).
[8] Mitchell (1975) quoted in Zemsky and Yablokov, 1974.
[9] (Zemsky and Yablokov, 1974).
[11] (Zemsky and Yablokov, 1974).
[12] (Danilevsky and Tyutyunnikov, 1968).
[13] (Danilevsky and Tyutyunnikov, 1968).
[14] (Danilevsky and Tyutyunnikov, 1968).
[15] (Zemsky and Yablokov, 1974) summer fishery restriction as of 1 May 1966.
[16] (Zemsky and Yablokov, 1974) catch effectively zero, amounting to "several dozens a year only".
[17] (Zemsky and Yablokov, 1974).
[18] (Zemsky and Yablokov, 1974).
[19] (Danilevsky and Tyutyunnikov, 1968).

introduced, which increased gear effectiveness (Zemsky and Yablokov, 1974). It does not appear, further, that any respite which may have occurred during the war benefited the porpoise populations appreciably. The catch of 5 600-7 400 animals per year reported for 1964 to 1966 represents a major collapse of the fishery (Danilevsky and Tuyutyunnikov, 1968). Accompanying this there has apparently been a marked change in the composition of the catch, by age, sex and species. It seems that earlier the catch was roughly equally divided between the sexes. In the 1963 and 1964 seasons the catch was composed of 70-75 % young, and pregnant or nursing females. This may have been associated with an extension of the fishing grounds (Danilevsky and Tuyutyunnikov, 1968). Similarly, the predominant species in the catch changed from *D. delphis* (80-90 %) to *P. phocoena* (Danilevsky and Tuyutyunnikov, 1968).

Note that *P. phocoena* is a small animal, with a maximum length of 167 cm for males and 180 cm for females (Tomilin, 1967). The maximum weight appears to be around 56 kg (Danilevsky and Tuyutyunnikov, 1968). This compares with maximum lengths of the order of 2 and 3 m for *D. delphis* and *T. truncatus*, respectively.

Referring again to Table 1, the Turkish fishery as reported is obviously important, and especially now when stocks are probably reduced. Despite the upheaval during the second world war, and the cessation of the Soviet fishery, the Turkish fishery continued (Danilevsky and Tuyutyunnikov, 1968). In addition, the use of guns means that the loss rate is high. In the period 1951-56 the average annual catch exceeded the maximum Soviet annual catch in 1938. Similarly, the reported catch in the last 2 years has approached that 1938 maximum. These data together with the high loss rate, suggest either an extremely intense fishery on a locally greater abundance of porpoise, or

Table 2. Population size estimates in thousands, their natural logarithm, and percent change between years, after Zemsky and Yablokov, 1974.

Year	*Tursiops*			*Delphinus*			*Phocoena*			Total		
	Pop. ('000)	Nat. log.	% Change	Pop. ('000)	Nat. log.	% Change	Pop. ('000)	Nat. log.	% Change	Pop. ('000)	Nat. log.	% Change
1967	65.7	4.19	+ 9.1	145.6	4.98	− 80.6	23.3	3.15	+ 25.3	234.6	5.46	− 44.9
1968	71.7	4.27	+ 91.1	28.3	3.34	− 7.1	29.2	3.37	− 58.2	129.2	4.86	+ 35.8
1969	137.0	4.92	− 73.0	26.3	3.27	+457.0	12.6	2.50	+100.8	175.5	5.17	+ 18.5
1970	37.0	3.61	+280.5	146.5	4.99	+ 94.3	24.5	3.20	− 25.3	208.0	5.34	+113.4
1971	140.8	4.95	− 19.4	284.7	5.65	− 11.8	18.3	2.91	− 19.7	443.8	6.10	− 14.6
1972	113.5	4.73	− 72.7	251.0	5.53	− 16.0	14.7	2.67	+126.5	379.2	5.94	− 27.4
1973	31.0	3.43		211.0	5.35		33.3	3.51		275.3	5.61	− 15.1
1974		–			–			–		(233.7)		
Mean	85.24		91.0	155.77		111.1	22.21		59.3	263.66		45.0
SDEV	45.46			102.24			7.64			112.35		
SD ERROR	17.18			38.64			2.89			42.46		
MEAN (LN)	4.30			4.73			3.05			5.50		
SDEV (LN)	0.61			1.00			0.36			0.43		
SER (LN)	0.23			0.38			0.14			0.16		

gross inaccuracies in the catch statistics. If the former, it does seem likely that a fishery of this magnitude could cause a reduction in the porpoise populations. This will be discussed in conjunction with the estimates of stock sizes.

With shifting species and age and sex composition it is unlikely that the numbers of dolphin per metric tonne of reported catch has remained constant. With the shift toward *P. phocoena* in the latter part of the fishery the average weight probably declined and hence the estimates of numbers killed are probably too low. In order to evaluate truly the impact of the fishery it is important to be able to determine the numbers of animals rather accurately.

Population sizes

The aggregate population size of all species of porpoise in the Black and Azov Seas was estimated for the thirties at 1.5 to 2.0 million animals (Arseniév, Zemsky and Studenetsskaya, 1973; quoted by Zemsky and Yablokov, 1974).

In conjunction with the Soviet moratorium on harvesting porpoise, aerial surveys have been conducted twice a year since 1967. These have been designed to obtain estimates of the population sizes of the various species, and were apparently the basis of population estimates quoted in *Nature* (Anon., 1974). Since that article[1] additional information on these estimates of population size have become available in Zemsky and Yablokov, 1974. These authors provide estimates by species, as shown in Table 2. It can be seen that these estimates vary considerably from year to year and that no obvious trends are identifiable. In Fig. 1 the natural logarithm of the population

[1] Note that in 1973 the population estimate is here given as 800 000, "three times the 1965 figure". I have no figure for 1965 and the 1973 estimate given in Zemsky and Yablokov, 1974, is 275 300 animals.

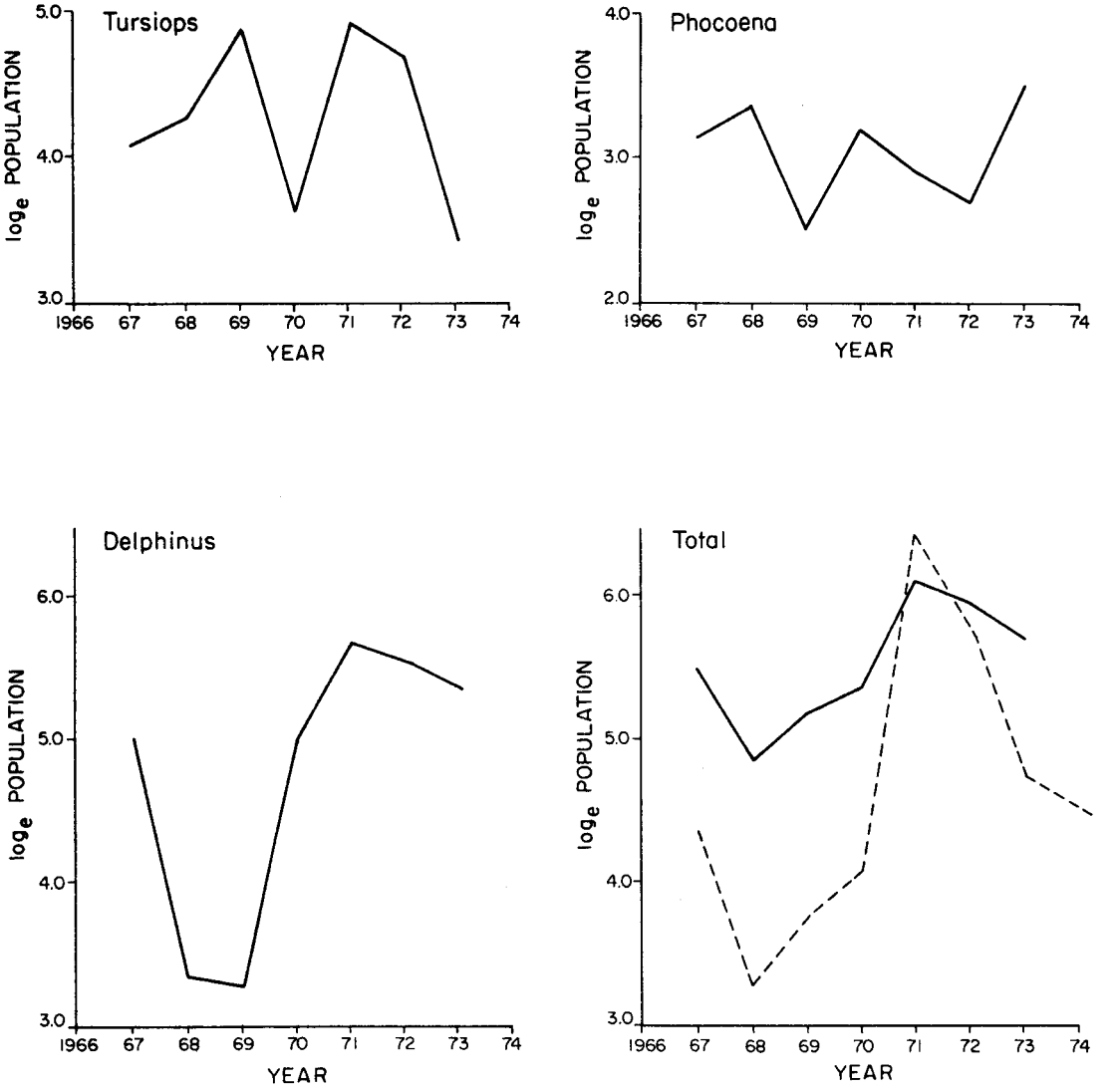

FIG. 1. — Logarithms of population size versus year for estimates of porpoise population size given in Zemsky and Yablokov, 1974, by species and total.

size estimates is plotted against time. It does not seem likely that cetacean populations, with their low reproductive rates and long lifespan, could experience fluctuations of this magnitude.

Some of the assumptions made in deriving these estimates are given. These include: (i) random distribution of porpoise; (ii) search of a path 3.0 km wide, and (iii) counting of one half of the animals in this path.

From personal coversations, I understand that:

- some large schools were seen and counted outside this path;
- the aircraft left the track line if the sighted school was large for a close fly by, and then returned to the track;
- the flight speed was 4 km/min;
- the area of the Black Sea inhabited by porpoise is 413 000 km^2;
- there are no small cetaceans in the Azov Sea (because of pollution), and
- the same route-march or trackline was followed on each of the surveys.

The location of this track is not given. It is not known how the results from the 2 surveys were combined each year.

Several comments are given in Zemsky and Yablokov (1974) about these estimates of population size. The estimates of the *Delphinus* population size are considered more reliable than those for *Phocoena* and *Tursiops*, because *Delphinus* is a more pelagic animal and the other 2 more inshore.

The high variability of these estimates, even for the more pelagic *Delphinus* population, appears most likely due to a failure to meet the assumption of randomness of the spatial distribution of the populations. Some information on the biology of these 3 species is of interest here. As mentioned in Zemsky and Yablokov (1974), *Phocoena* and *Tursiops* are generally found nearer shore than *Delphinus*. Sokolov (1971) referring to Kleinenberg (1956) describes *Tursiops truncatus* as feeding generally on benthic organisms, fairly near shore. It is restricted in distribution to the northern and eastern shores of the Black Sea (Tomilin, 1967). Sokolov also describes *Phocoena phocoena* as being a benthic fish feeder in coastal waters, but also a pelagic feeder in deep water. This species also feeds on anchovy-like fish when these occur in dense schools. This pelagic feeding is apparently most important in the spring and autumn (Tomilin, 1967). It is thought that *P. phocoena* feeds extensively on the Azov anchovy as it migrates from the region around the Caucasus Mountains north through the Kerch Strait into the Azov Sea. Danilevsky and Tyutyunnikov (1968) suggest also that *P. phocoena* winters on the Anatolian coast (West Turkey) and that it does not enter the Azov Sea. This latter point was also suggested by Yablokov (pers. comm.), citing pollution levels.

In distinction to these other 2 species, *Delphinus delphis* is a pelagic animal, feeding primarily on anchovy (*Engraulis encrasicholus*) and sprat (*Spratella spratus phaleriza*). Tomilin (1967) suggests that *D. delphis* feeds on local concentrations of these fish. Congregations of this porpoise will form over a concentration of fish for periods of 1 to 2 months. These 2 food species apparently spawn at different seasons, dispersed over the Black Sea, but form dense concentrations in the non-spawning season. The anchovy is a summer spawner and the sprat a winter spawner.

This biological background allows the assumption of random distribution to be evaluated. First, the assumption that *T. truncatus* and *P. phocoena* are distributed over the whole Black Sea, let alone randomly, appears questionable. It would seem necessary to obtain a better understanding of the area inhabited at the time of the survey. However, the assumption of these species being distributed over the whole area should result in a systematic bias, not in high variability. Second, the large concentrations of *D. delphis* feeding on the anchovy during the summer (the time of the surveys) will tend to increase the variability of the resulting estimates. As the track lines were not randomly placed this could also result in a possible bias in the estimates. This aspect could be evaluated further by examining the variability between the surveys within a year.

The accurate determination of the area inhabited is important to avoid a consistent bias in the resulting population estimates. Similarly, the accurate determination of the path effectively searched is important. The assumption of seeing one half of the animals within a 3 km path implies an effective path width of 1.5 km, or 0.75 km on a side. One interpretation of this is that the number of sightings made is the same as would have been made if a path 0.75 km on a side had been inspected completely.

Using this figure, one obtains the proportion of the area effectively searched as $(8\,000 \times 1.5/413\,000) = 0.029$. Thus the number of animals sighted would be divided by this fraction to obtain the total population estimate.

This assumed path width can be checked against 2 other examples. Tomilin (1967) reports on observations made from an aeroplane in the late thirties, referring to Tsalkin (1936-38) and Golenchenko (1939). The sources of these references are not available. Flying at a speed of 130-180 km/h and at 200-500 m altitude, Tomilin suggests it is possible to see dolphin schools up to a maximum distance of about 7 km. He also reports that "most convenient" observation can only be made if the aircraft flies directly over or within approximately 1.5 km of the school. Tomilin notes that visibility deteriorates markedly if the sea state exceeds Beaufort 2. The assumption made about visibility is not inconsistent with these values, although perhaps soewhat conservative.

The second comparison is with figures given in Smith (1975). In an aerial survey in the eastern tropical Pacific in early 1974, the distance of sighting of each school was recorded. An average distance at which schools were sighted of 1.4 km was reported. Following Seber (1973) this average sighting distance can be interpreted as the effective path search on 1 side of the aeroplane.

This can be compared with the value of 0.75 km computed above, suggesting that the visibility in the Black Sea surveys is much less than that in the eastern tropical Pacific survey, or that one or more of the assumptions listed above are false.

Status of the stocks

A simple statistic which can be used to evaluate the impact of harvesting on a population is the crude exploitation rate, the ratio between the total number harvested and the total population size. In the Black Sea porpoise harvesting, the kill is not generally available by species, so it is necessary to compute this ratio for all stocks taken together.

In the thirties the total size of all stocks was estimated at 1.5-2.0 million. Comparing this to the estimated kill in 1936 of 0.25-0.36 million, one obtains a crude exploitation rate in the range of 12.5-20.0 %.

It is difficult to choose a most probable population size from the estimates given in Zemsky and Yablokov. However, if the general range of the estimates of 129 200-444 000 animals is reasonable, the current exploitation rates due to the Turkish kill can be computed. The estimates of the Turkish kill in this decade vary from 35 200-130 000 animals per year. These estimates suggest crude exploitation rates of 7.9-100.8 %. The observation that the Turkish harvesting has continued at high levels in 1973 and 1974 suggests that the population estimates are probably in the high end of the range.

Beyond these crude analyses there is little that can be said about the status of the stocks. The problems with the available estimates of population size, and probably also with the kill estimates, preclude a consistent understanding. It would appear necessary to refine both of those statistics, but especially the population size estimates. As discussed above, this latter would be possible by better determining both the area inhabited at the time of the survey and the effective path width searched.

Summary

I have assembled and reviewed what is available to me on the status of the Black Sea small cetacean populations. It is apparent that a fishery directly on these animals has reduced their abundance to marginal levels. By 1966 this reduction was sufficient to cause management action to be taken in some countries. The kill was probably excessive at the height of the fishery (12.5-20.0 %), and may still be so today (7.0-100.8 %).

However, the information on numbers killed and on numbers in the population is not sufficiently precise to allow for definite statements. Perhaps the most telling observation is that the numbers of small cetaceans in the Black Sea has declined substantially.

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