

PROGRESS REPORT ON THE 1995 BAHAMA BANKS BLUEFIN TUNA AERIAL SURVEY

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SUMMARY

An aerial survey was conducted from 19 May - 9 June, 1995, to document the apparent abundance and migration behavior of giant bluefin (*Thunnus thynnus*) over the Bahama Banks region, Straits of Florida. Two profession bluefin spotter pilots with single engine aircraft flew a daily 7 nmi transect survey flanking "Tuna Alley", and discovery flights to search for bluefin in adjacent areas. Spotter aircraft carried a data acquisition system consisting of a GPS, laptop computer, and a 35 mm camera to photograph schools. A total of 839 giant bluefin were seen on 10 out of 17 survey days, with peak sightings occurring in the first week of June. Total counts were within range of counts obtained in the 1974-76 surveys (368-3,125 bluefin). Singles and loosely aggregated schools of up to 100 bluefin travelled north along the Bank, and did not engage in feeding, busting, or cartwheeling behaviors exhibited by giant bluefin in New England waters. All sightings appeared to be large giants of at least 500 lbs and ranging to 650 lbs and over. There is little information documenting the origins and previous locations of giant bluefin in the Bahama Banks migratory assemblage. Examination of bluefin catch records and oceanographic conditions occurring in adjacent regions might provide additional information.

RESUMÉ

Une prospection aérienne a été menée du 19 mai au 9 juin 1995 pour documenter l'abondance apparente et le comportement migratoire des thons rouges (*Thunnus thynnus*) "géants" dans la région du Banc des Bahamas, dans les détroits de Floride. Deux pilotes professionnels de la détection de thon rouge ont survolé avec un avion monomoteur une section de 70 milles nautiques tout le long de la "Tuna Alley", et ont effectué des vols de reconnaissance à la recherche de thon rouge dans les zones adjacentes. Les avions avaient à leur bord un système d'enregistrement de données qui consistait d'un GPS, un ordinateur portable et un appareil de 35 mm pour photographier les bancs. Ils ont observé 839 thons rouges géants pendant 10 des 17 jours de travail, la plupart durant la première semaine de juin. Le total était de même ordre que celui qui avait été observé pour les prospections réalisées en 1974-76 (368-3, 125 thons rouges). Des poissons isolés et en bancs de structure floue comptant jusqu'à 100 poissons se déplaçaient vers le nord en suivant le Bank, sans montrer d'activité trophique, ni ludique, comme ce qui est observé chez les grands thons rouges des eaux de Nouvelle-Angleterre. Il semblerait s'agir de "grands géants" d'un poids minimum de 500 livres pouvant aller jusqu'à 650 livres ou plus. Il y a peu d'information sur l'origine et la situation antérieure du thon rouge géant dans la structure migratoire du Bahama Banks. L'examen des registres de capture de thon rouge et des conditions océanographiques dans les régions adjacentes pourrait donner une information supplémentaire.

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RESUMEN

Del 19 de mayo al 9 de junio de 1995, se llevó a cabo una prospección aérea para documentar la aparente abundancia y comportamiento migratorio del atún rojo gigante (*Thunnus thynnus*) por la región del Banco de las Bahamas, Estrecho de Florida. Dos pilotos profesionales de reconocimiento con un avión monomotor sobrevolaron diariamente un transecto de 70 millas náuticas a lo largo de "Tuna Alley", y realizaron vuelos de reconocimiento en busca de atún rojo en zonas adyacentes. Los aviones llevaban a bordo un sistema de registro de datos que consistía en un GPS, un ordenador portátil y una cámara de 35 mm para fotografiar los cardúmenes. Observaron 839 atunes rojos gigantes en 10 de los 17 días de trabajo, la mayor parte durante la primera semana del mes de junio. El total era similar al observado en las prospecciones realizadas en 1974-1976 (368-3, 125 atunes rojos). Peces individuales y cardúmenes en grupos algo dispersos de hasta 100 ejemplares, se desplazaron hacia el norte por la región del Banco, sin presentar las actividades tróficas, juegos o saltos, observados en los atunes rojos gigantes en aguas de Nueva Inglaterra. Parecía tratarse de grandes gigantes de al menos 500 libras y entre 650 libras y más. Hay poca información acerca de los orígenes y localización previa de atún rojo gigante en las agregaciones migratorias del Banco de las Bahamas. Se podría obtener más información examinando los registros de captura de atún rojo gigante y de las condiciones oceanográficas en las regiones adyacentes.

INTRODUCTION

In the 1950's, and later in 1974-76, the U.S. NMFS fisheries scientists conducted aerial surveys for bluefin tuna (*Thunnus thynnus*) migrating along the Bahama Banks region (Rivas, 1954;1978). It is generally believed that giant bluefin travel along the Straits of Florida from late April through mid-June on their way to seasonal feeding grounds at higher latitudes. The bluefin occurring on the Bahama Banks are large (400 lbs and above), and are believed to have recently spawned in the Gulf of Mexico or in the Straits of Florida (Rivas, 1978).

Recreational fishermen and researchers identified a narrow region of the Bahama Banks off South Cat Cay as Tuna Alley because traveling schools seem to concentrate in this region and are easily visible by air (Rivas, 1954; 1978; Anonymous, 1975). In three surveys conducted in 1974-1976, a mile-long, 60 minute transect flight was conducted on suitable weather days, with total yearly transect effort ranging from 38-52 hours (Rivas, 1978). The number of bluefin encountered was multiplied by the number of minutes in a day to derive a daily abundance estimate. This was then multiplied by the assumed 50-day migration interval to derive an estimate of spawning population size. This value ranged from 9,630 to 99,360 over the three year survey period. The appearance of bluefin was linked strongly with environmental factors such as wind speed, and less strongly with wind direction, lunar phase, and tide (Rivas, 1978).

From 19 May-9 June, 1995, we conducted an aerial survey of this region in order to identify bluefin migration patterns and general abundance. Our objectives were to determine the feasibility of developing a direct assessment of migrating bluefin, and to compare the results of the present study with those obtained in previous surveys.

METHODS

Bluefin tuna were sighted and counted by two tuna spotter pilots each having over 20 years of experience in the commercial tuna purse seine fisheries. Spotters flew single engine aircraft (Supercub, tailnumber 344Z; Cessna 172, tailnumber 270Q) and carried one observer on 7 out of 17 survey days. Flights originated from Executive Airport, Fort Lauderdale, FL and

required approximately a 40 min transit to reach the Bahama Banks area near north Bimini (fig. 1). Spotter aircraft carried a data acquisition system (Tunalog, Cascadia Research, Inc.) consisting of a GPS, laptop computer with mouse (for event marking), and 35 mm camera to photograph schools, similar to that used in the New England bluefin spotter survey (Lutcavage and Kraus, 1995).

Fish spotting commenced immediately upon reaching the Florida Straits. On each day the Supercub surveyed a transect of approximately 60 nmi in length along Tuna Alley, beginning at a southernmost point near 24° 45', following a zigzag pattern north (fig. 1). Surveys were conducted at an altitude of 750-1000 feet and a true airspeed of 80 knots. The transect legs were flown to points approximately 3 nmi west of Tuna Alley. Each transect's starting point rotated among five locations so that the legs would be offset slightly. The transect was repeated if weather conditions permitted.

The second aircraft (Cessna 172) did not fly dedicated transects, but was instructed to search new areas for bluefin in order to locate, photograph and observe the behavior of any encountered. The spotter was free to determine his own search patterns, and on occasion carried an observer.

At the beginning of each survey and at the end of each transect leg pilots recorded their estimation of wind strength and direction, visibility, and water color. During surveys they were instructed to mark the location of all sighted bluefin and document them with photographs when possible. Radio contact with local sport fishing boats targeting bluefin allowed us to collect general information on sea surface temperature, sizes of landed fish, and additional sightings.

RESULTS

Spotters flew a total of 11,910 nmi. (158 hrs), encountering bluefin on 10 out of 17 survey days. Approximately 7,126 nmi. (114.5 hrs) were flown over the Bahama Bank, of which approximately 25% (usually 2 transects day⁻¹) were on transect. Spotters documented 53 bluefin schools and estimated a total count of 838 bluefin. No bluefin were sighted on any transits over the Florida Straits, although sea turtles, sharks, dolphins, and flying fish were sighted on numerous occasions. Other sightings on the Bank near Tuna Alley included loggerhead sea turtles, unidentified dolphins, tiger and other sharks, a single sperm whale, schools of skipjack tuna, chub, permit, and other unidentified fish.

Assemblages ranging from single bluefin to loosely aggregated schools of up to 20-100 individuals were sighted, and all were judged by spotters to be large giants (> 500 lbs). Bluefin were first observed in the vicinity on 24 May by a sport

fishing boat (MV Talley 7) but were not observed from the air until 28 May. Sightings peaked in the first week of June (Table 1), and declined gradually to the last survey day (9 June) when only one giant was seen. Based on interviews conducted with charter boat captains, the last fish was sighted on 11 June, whereupon the sport fleet left the area.

A preliminary account of sightings per unit effort (SPUE) and details of daily flights is given in Table 2. Daily transects were conducted by the Supercub on all survey days but 28 May. Surface seawater temperatures during the survey ranged from 26-29 °C, and the prevailing winds were primarily from the E/SE sectors (Table 1).

Although our analysis of environmental conditions is not completed, some general conclusions can be drawn. Tropical storm Allison in the Gulf of Mexico generated strong winds and squalls that affected the survey region beginning on 1 June. SPUE was highest from 1-4 June, associated with strongest winds, although fish were also seen on completely calm days with light and variable winds. In terms of the lunar calendar, peak sightings occurred in the period following the new moon on May 29. The largest school of nearly 100 fish was sighted at 09:53 on 1 June, and in general, peak sightings occurred between 09:00-13:00 hrs (Table 3).

DISCUSSION

The general behavior of giant bluefin observed in the Bahama Banks 1995 aerial survey was similar to that described previously (Rivas, 1954; 1978). Bluefin appeared on the Bank, particularly in the region between South Bimini and Castle Rock, with sighting concentrations near Victory and Gun Cays. The present aerial survey differed from those conducted in 1974-76 in having a survey line that ran for 60 nmi along and flanking Tuna Alley rather than the mile-long transect across it (Rivas, 1978). The present survey utilized two aircraft, producing a 3-fold increase in effort hours, but had only one third to half of the number of observation days than that of the 1974-76 surveys, which began in early May.

Singles and loosely aggregated schools swam steadily north, with the exception of one school that we followed for 36 min in the air. As two fishing boats approached from opposite sides the school of 10 changed conformation several times, turned west, and disappeared into deeper water. In general, the schooling behavior of Bahama Banks bluefin differed substantially from what we have observed in the Gulf of Maine, where they engage in obvious feeding and milling behaviors (Lutcavage and Kraus, 1995). Surface sea water temperatures when bluefin are present on the Bahama Banks and in the Gulf of Maine differ by as

much as 15 °C (Lutcavage, pers. obs.). In the Bahamas giant bluefin were much less tightly aggregated, and did not exhibit cartwheeling, feeding, or "busting" behaviors. In general, the large space between individuals made it much more difficult for pilots to photograph the entire school. In many cases individuals and schools would "show" at the surface for very short periods, then disappear quickly into the blue water below.

In general, spotters estimated that all of the bluefin they had encountered were large giants of at least 500 lb and ranging to 650 lbs and over. Three fish landed by anglers had reported straight fork lengths of 104", 107", and 110", respectively.

In general, as in previous surveys peak sightings occurred under conditions of strong winds, but 121 out of 838 fish were sighted under calm/or variable wind conditions. Experienced tuna guides emphasized that bluefin do not appear on the Bank until winds are of sufficient strength from the Southern sector, and/or when the Gulf Stream's edge intercepts the Bank, producing stronger northerly flow. Previous reports have also noted the bluefin's apparent avoidance of the "dirty water" tidal flow off of the Bank, which varied a good deal over the survey period. However, on at least two occasions we observed fish in turbid water.

It is possible that the apparent linkage of strong winds with appearance of bluefin on Tuna Alley may be driven by oceanographic conditions occurring in adjacent "staging" areas. In general, flow over the Bahama Bank in the Bimini area is weak, and driven by wind and tide (Dr. Tom Lee, Un. of Miami, pers. commun.). Although the Bank itself constitutes a topographic wall, it is not associated with strong upwelling. However, much stronger flow and upwelling occurs where the Loop Current leaving the Gulf of Mexico impinges on the north coast of Cuba. The dynamics of eddy systems near the Cay Sal Bank and northern Cuba could conceivably influence travel routes of bluefin. This is reinforced by the reports of giant bluefin on Cay Sal Bank and the Old Bahama Channel by anglers and fish spotters (Rivas, 1954; 1978), and would be one explanation for the large variability in numbers of bluefin sighted on Tuna Alley from year to year (e.g. an order of magnitude difference in sightings between 1974 and 1975, Rivas, 1978).

There are numerous reports of bluefin in other areas of the Bahamas and Straits of Florida beyond Tuna Alley, particularly to the east and northeast off Walkers Cay, the Abacos, and also in deep water regions west and southwest of the Banks and off Cuba (Rivas, 1978; , 1993-94; Edward Murray, pers. comm., 1995). Recent longline captures also corroborate the presence of bluefin in the eastern areas, well before the assumed migration period of fish transiting Tuna Alley (NMFS unpublished longline data). Giant bluefin were landed in the first week of June in the

Gulf of Maine, nearly coincident with our first sightings of fish in Tuna Alley. At present there is little information that would identify whether fish traveling across Tuna Alley are members of the same assemblage, and further, if they have recently exited the Gulf of Mexico, or have travelled from areas to the south and east.

It is clear that without additional oceanographic surveys, the sporadic appearance and diffuse aggregation behavior of giant bluefin on the Bahama Bank present serious problems for direct aerial assessment in this region. Although fish can be seen and enumerated, there is no way of determining how many fish transit the Straits of Florida in deeper water, or their presence and abundance in other regions of the Bahama islands. In the future, hydroacoustic studies, and examination of oceanographic conditions occurring in the Loop Current, Cay Sal Bank and north Cuban coast might provide information that could be used to forecast the appearance and relative abundance of bluefin across the western Bahama Banks.

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Table 1. Bluefin Tuna Aerial Survey of the Bahama Banks, 19 May-9 June, 1995

Seawater Temp (°C)	Date	Total count	Total no. of schools	Winds (knots)	
				North end	South end
	05/19	0	0	S 15-20	
	05/21	0	0	SSW 10-15	
	05/22	0	0	WNW <10	WNW 10-15
	05/23	0	0	WNW 8	
26.4	05/25	0	0	ENE 10-15	
	05/26	0	0	CALM	
26.7	05/28	8	1	ENE 8	SSE 10-12
28.6	05/29	8	2	E 15	E 12-15
29.2	05/30	45	4	CALM	ESE 8-10
28.9	05/31	75	9	CALM	SE <10
28.9	06/01	181	3	E 10-12	ESE 15-20
	06/02	125	9	ESE 20	SE 20-30
29	06/03	149	10	SSE 20	ESE 25-30 (squalls)
27.9	06/04	186	8	ESE 12-15	S/E 25+ (squalls)
28.5	06/07	59	5	WSW 15	W 5-8
29	06/08	1	1	NNW 8-10	WSW 8 (squalls)
	06/09	1	1	CALM	
Totals		838	53		

Sea water temperatures provided by charter boat. Wind speed and direction estimated by pilot based on sea state.

Table 3. Aerial sightings of bluefin tuna by hour

Time	Schools	Counts
8-09:00	1	1
9-10:00	2	180
10-11:00	10	109
11-12:00	14	232
12-13:00	17	212
13-14:00	5	80
14-15:00	3	17
15-16:00	0	0
16-17:00	1	8

Table 2. Bahama Banks 1995 Bluefin Aerial Survey sightings analysis.

Aircraft	Date	Start time	End time	Total time (hr)	Total nmi	nmi on Banks	N Sight	N BFT	SPUE	BFSPUE
over Banks										
344Z	5/21/95	9:15:0	12:56:15	3.7	249	139	0	0	0	0.00
270Q	5/22/95	9:48:0	15:59:15	6.2	441	331	0	0	0	0.00
344Z	5/22/95	9:47:15	15:41:30	5.9	388	278	0	0	0	0.00
270Q	5/23/95	9:17:25	15:52:15	6.6	424	314	0	0	0	0.00
344Z	5/23/95	9:18:15	15:49:15	6.5	440	330	0	0	0	0.00
270Q	5/25/95	9:52:15	15:58:30	6.1	438	328	0	0	0	0.00
344Z	5/25/95	9:42:30	16:44:45	6.4	406	296	0	0	0	0.00
270Q	5/26/95	9:23:15	13:11:15	3.6	268	158	0	0	0	0.00
344Z	5/26/95	9:23:45	12:56:45	3.6	244	134	0	0	0	0.00
270Q	5/28/95	9:46:0	17:13:30	7.5	540	430	1	8	0.0023	0.02
344Z	5/29/95	9:9:15	15:44:45	5.9	383	273	0	0	0	0.00
270Q	5/30/95	9:21:45	15:24:45	5.7	364	254	3	37	0.0118	0.15
344Z	5/30/95	9:20:0	15:03:30	5.7	372	262	1	8	0.0038	0.03
270Q	5/31/95	9:23:15	14:58:45	5.6	345	235	3	30	0.0127	0.13
344Z	5/31/95	9:17:15	14:57:30	5.7	374	264	6	45	0.0227	0.17
270Q	6/1/95	7:13:0	13:9:15	5.9	348	238	2	81	0.0084	0.34
344Z	6/1/95	7:13:30	13:14:0	6.0	399	289	1	100	0.0035	0.35
270Q	6/2/95	8:51:15	14:23:45	5.5	316	206	6	93	0.0291	0.45
344Z	6/2/95	8:44:30	14:22:30	5.6	341	231	3	32	0.013	0.14
270Q	6/3/95	9:11:30	14:18:0	5.1	297	187	4	84	0.0214	0.45
344Z	6/3/95	9:5:15	14:17:0	5.2	298	188	6	68	0.0319	0.36
270Q	6/4/95	9:54:15	13:8:30	3.2	206	96	4	90	0.0418	0.94
344Z	6/4/95	9:53:15	13:7:45	3.2	188	78	4	96	0.051	1.22
270Q	6/7/95	9:8:15	15:40:45	6.5	464	354	2	29	0.0057	0.08
344Z	6/7/95	9:2:15	16:5:30	7.1	445	335	3	30	0.009	0.09
270Q	6/8/95	9:34:30	15:31:0	5.9	425	315	1	1	0.0032	0.00
2285	6/8/95	9:38:15	15:28:0	5.8	384	274	0	0	0	0.00
270Q	6/9/95	9:54:15	13:54:30	4.0	268	158	0	0	0	0.00
2285	6/9/95	9:54:15	14:3:15	4.2	262	152	0	0	0	0.00

Abbreviations: nmi nautical miles, SPUE sightings per nmi, BF SPUE total bluefin per nmi. Distance over Banks was estimated as total flight miles minus 110 miles (distance over land/Straits of Florida).

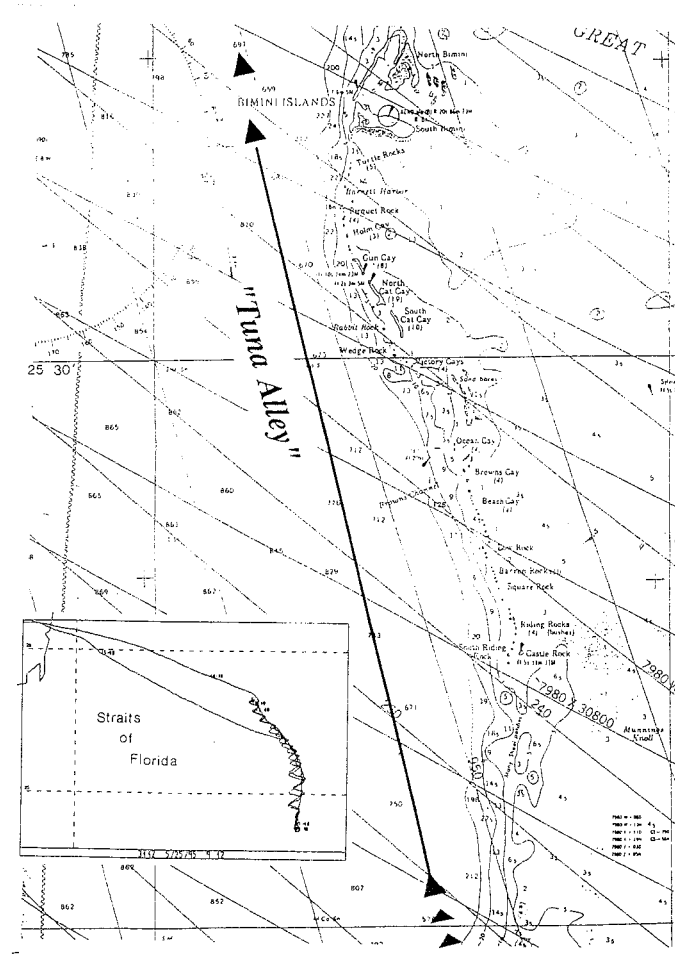


Fig. 1. Partial view of the study region showing the location of "Tuna Alley" along the western side of the Bahama Bank. Inset is an example of the transect aircraft's transit (25 May) across the Straits and two line transects along Tuna Alley.