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ALBACORE FISHING AND WINDSPEED

Paul N. Sund

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U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Southwest Fisheries Center

NOAA Technical Memorandum NMFS

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CONTENTS

Figure Captions:

Figure 1. Fishing areas within the U.S. albacore fishery.

Figure 2. Frequency distribution of lengths of albacore vessels responding to the questionaire.

Figure 3. Relationship between jigboat lengths (x-axis) and windspeeds at which fishing was reported to stop (y-axis). Regression lines for all areas combined and different areas within the fishery (see fig.1) are included. PNW=Pacific northwest offshore; NC=north coastal; SC=south coastal; All=all areas combined.

Figure 4. Regressions describing relationships between jigboat vessel lengths and windspeed at which operations stop when fishing ("on fish") and when not fishing ("off fish").

Figure 5. Relationships between baitboat vessel lengths (x-axis) and windspeeds at which fishing was reported to stop (y-axis). Regressioon lines for north and south coastal areas combined (All) and for north and south coastal areas.

Figure 6. Relationship between windspeed at which jigboat fishing was stopped while ("on fish") and the cumulative frequency (percent) of those reported wind speeds. Regression plotted is a linear approximation of the relationship. Data from replies to questionaire.

Figure 7. As per figure 6. Data from charter vessel daily log sheets.

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INTRODUCTION

It is a general supposition that albacore fishing operations are subject to weather conditions. Attempts to determine the effect of windspeeds on catch rates and to develop a wind fishability index using environmental data from log books of albacore fishing vessels have been unsuccessful (Sund, 1984). Such an index could be used as input to albacore modelling efforts (Weber, 1982) to investigate the effect of an environmental factor on the interpretation of catch-effort. A possible reason for the failure was the fact that windspeeds are recorded on the fishing logs in categories of "calm", "less than 10", "10 to 20", "20 to 30", and "over 30" knots, which do not yield satisfactory resolution for such a study, particularly in the higher categories where the effect is anticipated. An alternate interpretation is that windspeed is not a factor on catch. The specific question remains as to how variations in weather conditions affect monthly and annual catch rates.

In order to further investigate the effect of windspeed on albacore fishing activities, a questionaire was mailed by the Western Fishboat Owners Association to its approximately 350 fishermen-members. It specifically asked for information on the windspeeds at which operations are stopped on albacore fishing vessels of different sizes and types in four specified areas of the fishery: north and south coastal regions, Pacific northwest offshore region and Midway region (Figure 1) The questionaire was mailed early in 1984, and thus reflects recent experience. This report uses the results of the questionaire survey as the basis for considerations of the influence of windspeed on the ability to fish.

It is recognized that windspeed, in itself, is not the single factor that determines fishable conditions for the albacore fleet. Fishability is determined by a combination of variables among which sea state probably represents the most important effect of wind. In addition, the direction of wind, sea and swell in relation to one another are expected to affect fishability. Interpretation of this complex of variables is beyond the scope of this study, which is limited to an attempt to describe the influence of windspeed as a single factor on albacore fishing. In the discussions that follow the assumption is made that the characteristics of the vessels that reported and their behavior with respect to wind and fishing is representative of the entire albacore fleet.

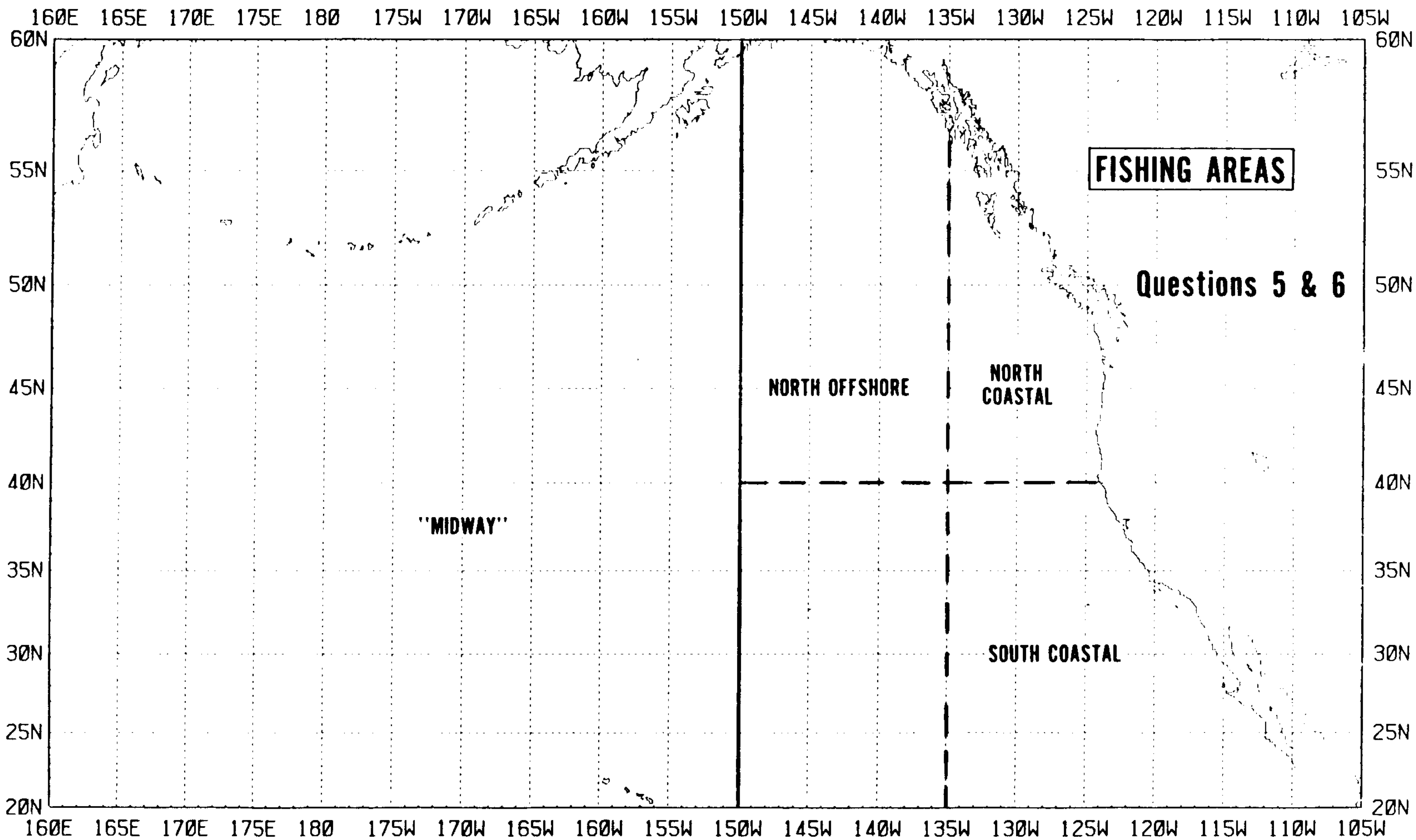

Figure 1. Fishing areas within the U.S. albacore fishery.

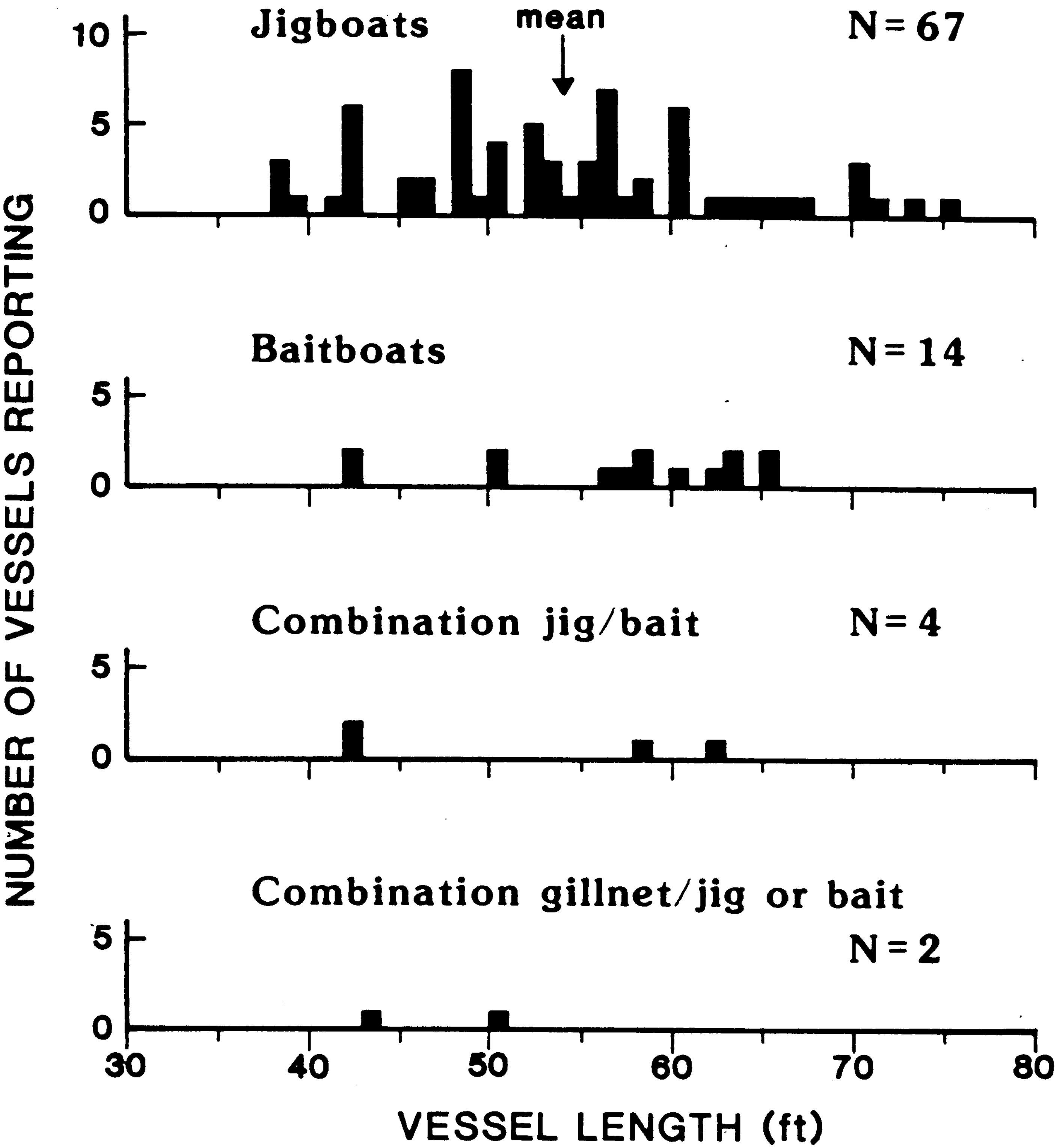

Figure 2. Frequency distribution of lengths of albacore vessels responding to the questionaire.

REPLIES TO QUESTIONAIRE

The principal questions asked in the questionaire were:

* Windspeed at which you stop fishing when on fish ("on fish")
* Windspeed at which you stop operations when not on fish ("off fish")

Replies were received from 87 persons. The distribution of replies by vessel type was:

67 jigboats,
14 baitboats,
6 combination vessels
(4 jig/bait,
1 jig/gillnet,
1 bait/gillnet).

The length frequency distribution of vessels that reported is illustrated in figure 2. Jigboats ranged in length from 37 to 75 feet with a mean length of 53 feet. The range in length of baitboats was 42 to 65 feet; for combination vessels, 42 to 62 feet.

No influence of wind on fishing operations of any vessel was reported for windspeeds below 20 knots. Some responses to the questionaire indicated that fishing took place in winds as high as 60 and 70 knots (Figure 3). Reports of fishing in such high winds may be due to how the questions in the questionaire were interpreted (eg.reporting of gust values rather than steady winds) or due to erroneous estimation of windspeeds (eg.lack of instruments). Apparently, few vessels have instruments for accurate measurement of winds.

JIGBOAT FISHING AND WIND:

Sufficient numbers of replies were recieved to justify statistical treatment of the data only for jigboats. The most important question asked, in terms of potential application to the albacore model, was at what windspeed operations stopped while fishing. The relationship of vessel length and the windspeed at which jigboat fishing was reported to cease is plotted in figure 3. Intuitively, one would anticipate larger vessels to be able to fish in higher winds. Indeed, such a relationship is evident, but there is a high degree of variability. Variability should be expected from subjective estimates of windspeed and also from vessels of varying characteristics, construction and sea-keeping ability, and also from varying tolerance to weather of individual operators.

Regressions were calculated to determine differences in behavior of vessels of different lengths with respect to windspeeds at which activity stopped while "on fish" or "off fish" (figure 4). Statistical values for the regressions are given in table 1. One might anticipate a tendency for continuation of operations in higher winds when on fish than when off fish. Such a difference was found, but it was small and statistically not significant. The regression equation predicts that, for example, a 45 foot long vessel would stop fishing while on fish at 34 knots and it would stop at 30 knots while off fish.

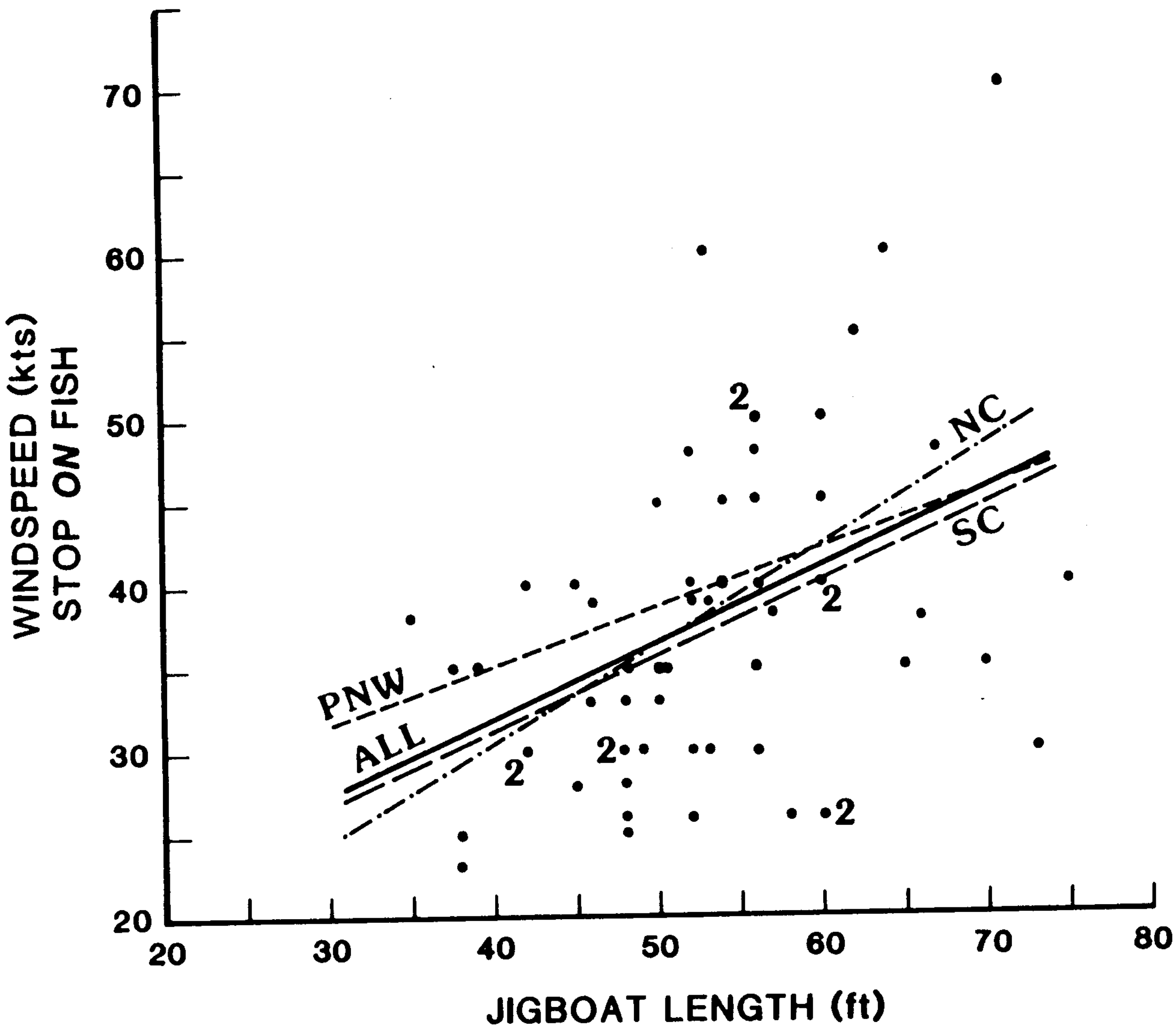

Figure 3. Relationship between jigboat lengths (x-axis) and windspeeds at which fishing was reported to stop (y-axis). Regression lines for all areas combined and different areas within the fishery (see Fig.1) are included. PNW = Pacific northwest offshore; NC = north coastal; SC = south coastal; All = all areas combined.

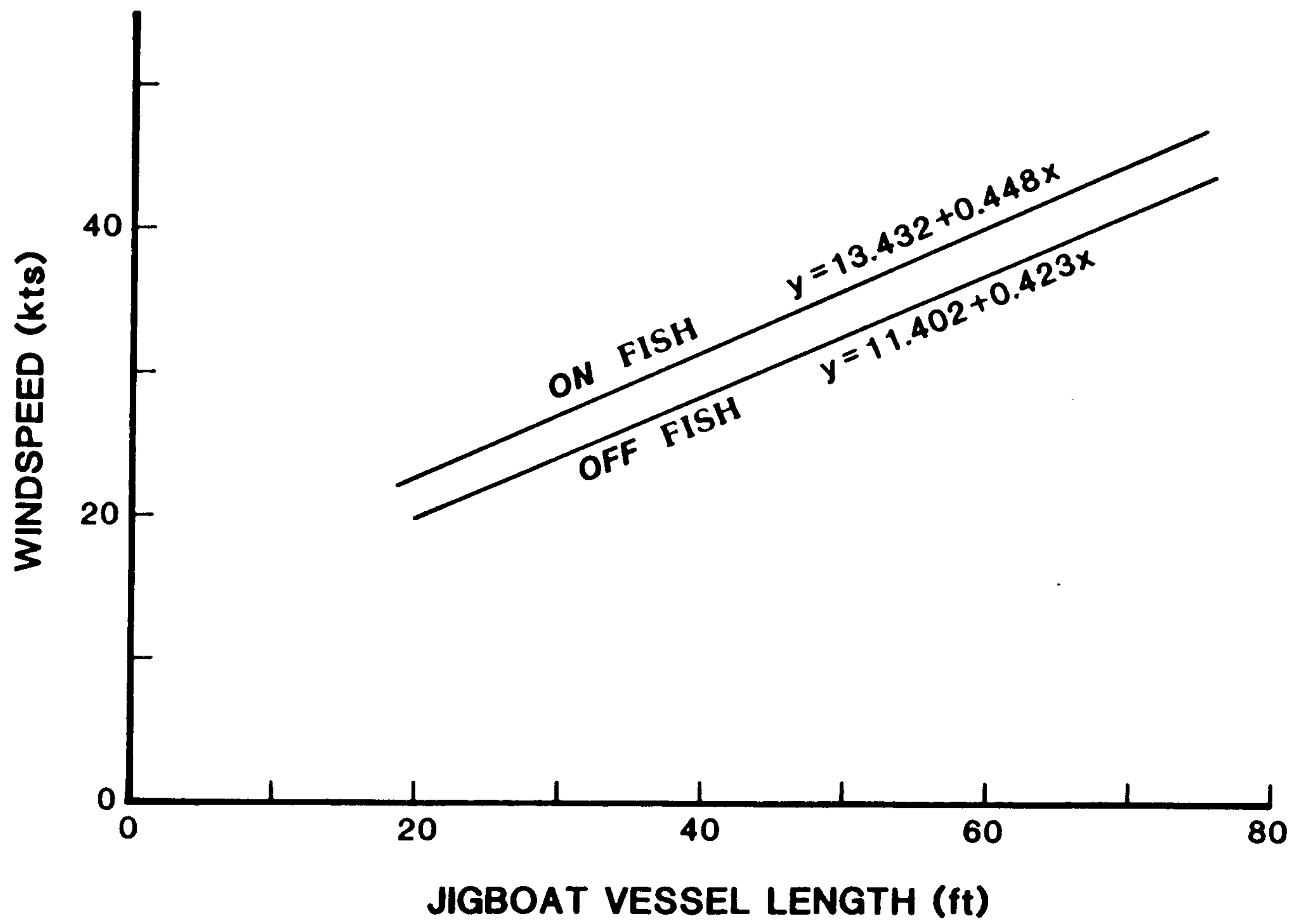

Figure 4. Regressions describing relationships between jigboat vessel lengths and windspeed at which operations stop when fishing ("on fish") and when not fishing ("off fish").

Table 1. STATISTICAL VALUES FOR THE RELATIONSHIPS BETWEEN JIGBOAT LENGTH AND WINDSPEEDS AT WHICH OPERATIONS STOP WHILE "ON FISH" AND WHILE "OFF FISH".

Activity	Intercept	Slope	R-Square	F-ratio	
ON FISH	13.43	0.45	.18	13.01	**
OFF FISH	11.40	0.42	.26	22.51	**

** = significant at alpha = 0.01

BAITBOAT FISHING AND WIND:

Replies were received from 14 baitboats which fished the north and south coastal areas. Most bait fishing was reported from the southern coastal area (13 vessels); seven boats reported fishing the northern coastal area. Figure 5 is a scatter plot showing the reported bait vessel lengths and the windspeeds at which fishing was stopped when on fish. Regression lines are included in the figure, but the data are too few to permit any conclusive statements to be made concerning the relationships for the different areas. The figure does reveal that none of the baitboats from which reports were received fished at windspeeds above 35 knots; and there is a trend indicating that larger vessels can operate in somewhat higher windspeeds than can smaller ones. The average size baitboat (56 feet) stops fishing when encountering windspeeds of about 25 knots. Any difference in fishing behavior of vessels in the two areas apparently is slight.

A WIND-FISHABILITY INDEX:

A regression was computed and plotted (Figure 6) relating the windspeeds at which jig fishing was reported to be stopped while on fish (x-axis) and the cumulative frequency (percent) of those reported windspeeds (y-axis). Obviously, this relation holds only for winds above approximately 20 knots, the minimum speed reported. The linear regression approximating the curvilinear relationship in figure 6 is

$$y = -47.40 + 2.76x,$$

where x = the windspeed at which fishing stops when "on fish", and
y = the cumulative frequency of the reported windspeed.

This relationship and the frequency distribution of windspeeds were used to compute the (hypothetical) percentage of time lost due to wind for sample times and areas within the fishery. These percentages comprise the wind-fishability index. The index was computed for four sample areas that represent actively fished portions of the respective sub-regions of the fishery. The regression was used to compute the amount of lost time per day according to the frequency distribution of daily mean wind speeds. From these, monthly means were calculated.

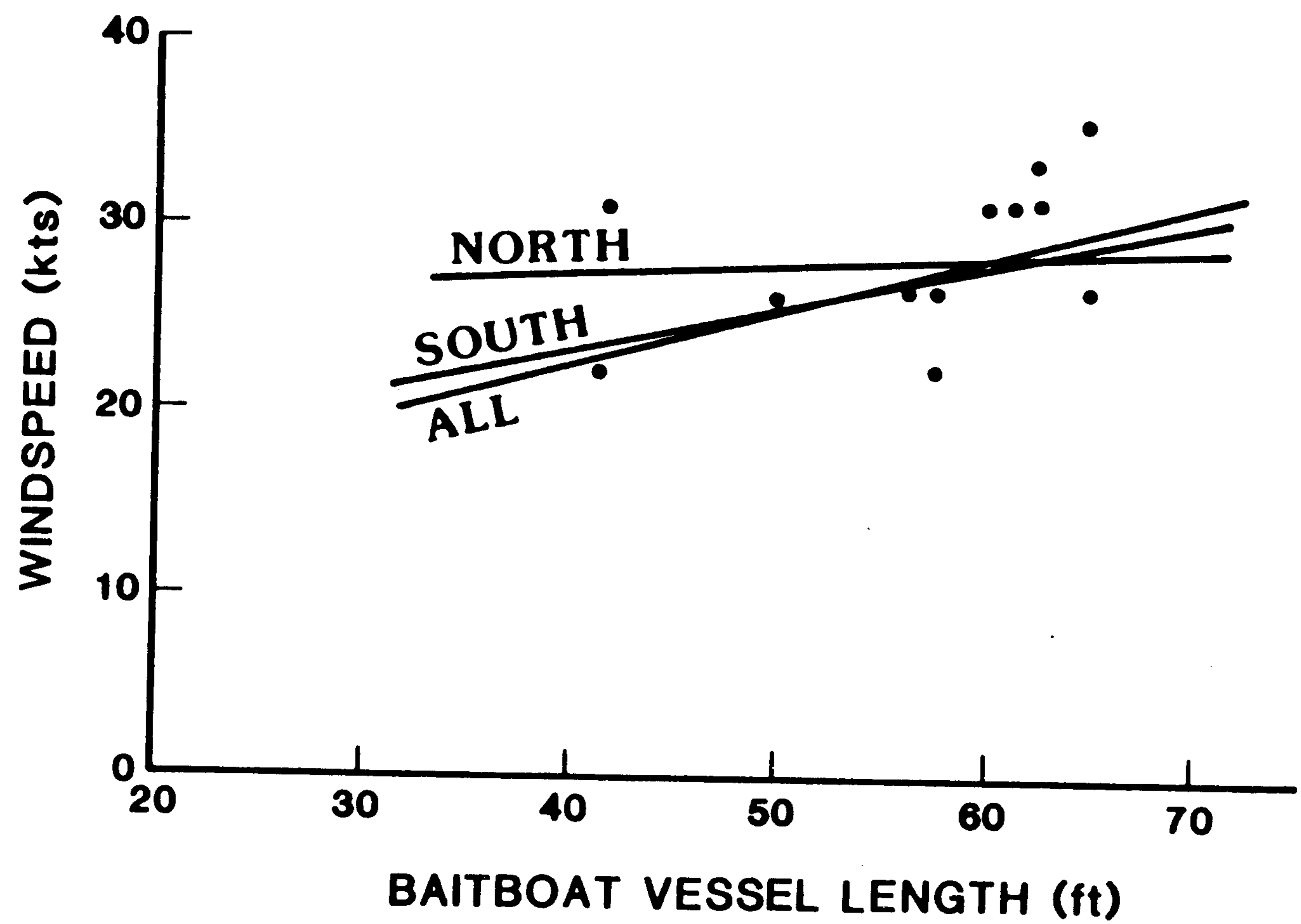

Figure 5. Relationships between baitboat vessel lengths (x-axis) and windspeeds at which fishing was reported to stop (y-axis). Regression lines for north and south coastal areas combined (All) and for north and south coastal areas.

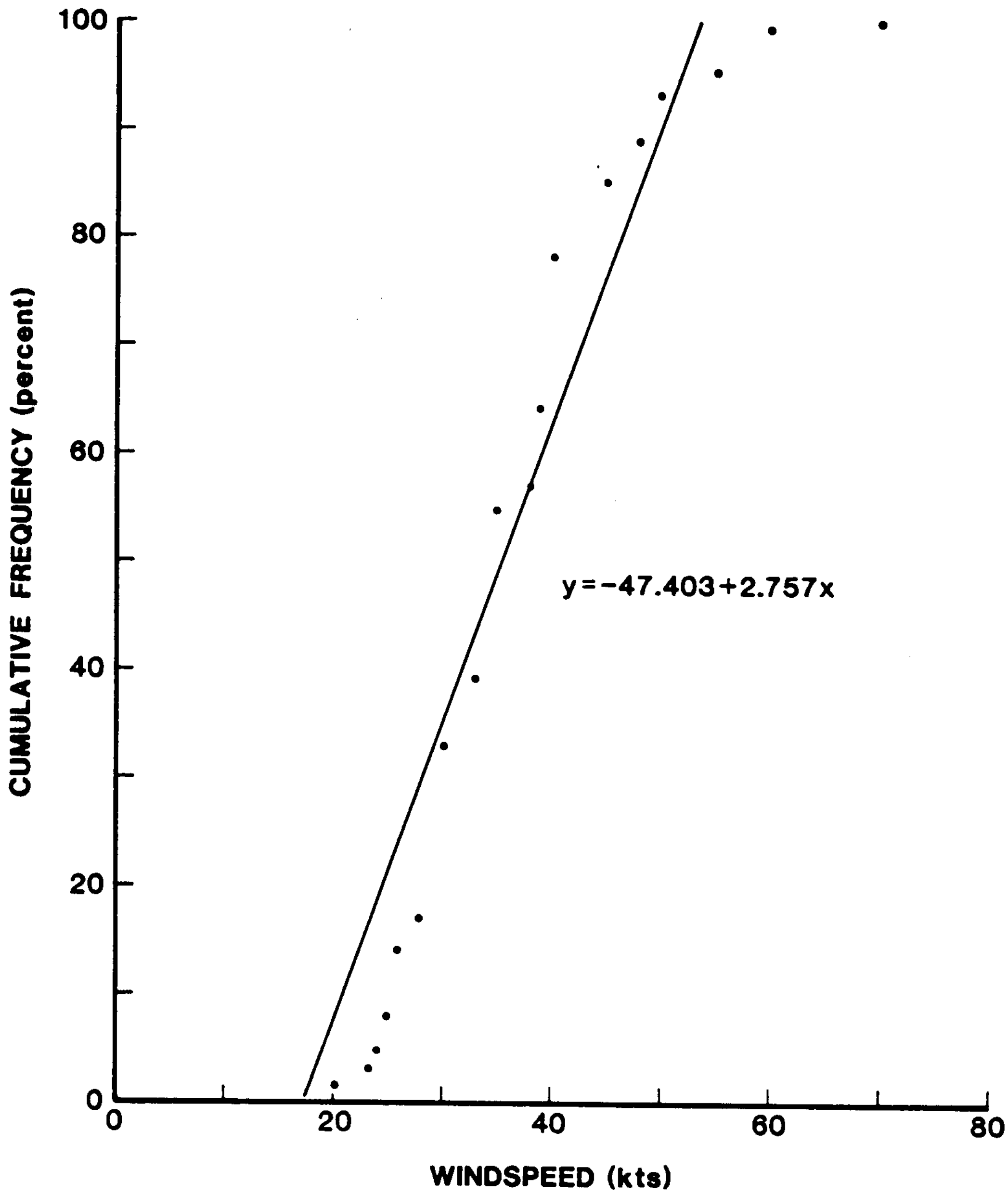

Figure 6. Relationship between windspeed at which jigboat fishing was stopped while ("on fish") and the cumulative frequency (percent) of those reported wind speeds. Regression plotted is a linear approximation of the relationship. Data from replies to questionaire.

The wind data used were daily mean windspeeds computed from six-hourly surface winds derived from the standard 63 by 63 FNOC grid of northern hemisphere pressure/wind fields (Anon., 1975). They represent wind conditions in areas three degrees longitude by three degrees latitude, centered at 33N, 125W (south coastal), 50N, 130W (north coastal), 45N, 145W (Pacific northwest offshore), and at 45N, 170W (Midway). For these areas during the years 1979 to 1983 the hypothetical fishing time lost per month is given in table 2. Such computations are possible for any area of the fishery or for any time period that may be specified, depending on the interests of the investigator.

Table 2. PERCENT OF FISHING TIME LOST PER MONTH (HYPOTHETICAL) FOR SPECIFIED AREAS, 1979 TO 1983.

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
AREA: 33N,125W: South Coastal												
1979	2	0	1	1	0	0	1	0	1	0	0	2
1980	1	7	3	1	0	0	0	0	0	0	0	0
1981	3	1	2	1	1	4	0	0	0	0	0	0
1982	2	1	0	1	0	0	0	0	0	0	0	2
1983	4	2	2	2	1	0	1	0	0	0	1	3
					<......season.......>							
AREA: 50N,130W: North Coastal												
1979	4	4	5	1	1	0	0	0	2	7	13	14
1980	6	8	1	7	1	1	0	1	2	5	8	11
1981	19	6	8	3	1	0	0	1	3	4	8	8
1982	5	3	3	2	2	0	1	0	1	3	3	5
1983	18	9	5	3	0	1	1	0	1	4	7	4
					<......season.......>							
AREA: 45N,145W: Pacific Northwest Offshore												
1979	4	4	9	3	4	0	1	0	9	10	8	14
1980	8	10	5	14	6	0	1	0	3	6	8	8
1981	12	12	8	5	5	4	0	4	7	4	16	6
1982	10	3	11	9	4	0	1	1	2	8	8	14
1983	18	10	12	5	5	7	2	0	1	3	7	8
						<....season.....>						
AREA: 40N,170W: Midway												
1979	14	3	10	5	3	1	3	0	2	7	2	10
1980	15	10	11	14	5	0	6	1	3	9	10	8
1981	10	14	17	4	4	3	1	1	2	2	8	13
1982	8	7	4	2	5	1	2	0	3	8	7	10
1983	5	6	14	2	3	5	1	2	3	3	10	8
					<..season..>							

The hypothetical loss of fishing time during the fishing season (duration varying with the particular sub-region of the fishery) is only on the order of zero to seven percent in the coastal areas, and up to ten percent in the offshore areas (Table 2). In the south and north coastal areas the percentages mostly are from zero to five percent, with only two higher values. In all four areas during months prior to and after the ususl fishing seasons, windspeeds are such that percentages of lost fishing time may be in the teens. If windspeeds high enough to adversely effect fishing operations occur only seven percent of the time or less during the seasons, one is led to conclude that windspeed, in itself, is not a significant factor affecting catch in the coastal portions of the fishery.

Two points of concern arise from the above results: (1) windspeeds reported for the stop-fishing conditions appear high relative to the resulting effect (e.g., according to the regression, only 50 percent of jig vessels stop fishing at 36 knots, 75 percent at 45 knots, etc.) and (2) the percentages of lost time seem low relative to the incidence of reports of stoppages. Therefore, alternative means were sought to investigate these problems.

Logbook data on windspeeds in which fishing occurred were compared for the fishery areas north and south of 40N for both jig and bait vessels (Table 3). In the three speed classes up to 20 knots, for each type of vessel there is a consistent pattern in percentages of records of fishing in the two areas. In the 20 to 30 knot speed class, the percentages for the vessel types differ, baitboats reporting fishing in winds of those speeds about 60 percent less frequently than jigboats. At windspeeds over 30 knots, the percentages essentially are identical for both types and areas.

Table 3. COMPARISON OF FREQUENCIES AND PERCENTAGES OF DAYS FISHED BY U.S.ALBACORE JIG AND BAIT VESSELS IN THE NORTH AND SOUTH COASTAL AREAS AT WINDSPEEDS RANGING FROM CALM TO OVER 30 KNOTS. DATA FROM LOGBOOK RECORDS OF AVERAGE DAILY WINDSPEED DURING FISHING SEASONS OF 1977 TO 1981.

	WINDSPEED(KTS)				
	CALM	<10	10-20	20-30	>30
NORTH OF 40N					
Jigboat	1502(24%)	1406(17%)	2296(37%)	1143(18%)	216(3%)
Baiitboat	37(39%)	21(22%)	26(28%)	7(7%)	3(3%)
SOUTH OF 40N					
Jigboat	1853(25%)	1693(23%)	2676(36%)	1007(18%)	210(3%)
Baitboat	403(37%)	271(25%)	324(30%)	76(7%)	18(2%)

For a large area of the north Pacific, the percentage of winds over 30 knots is approximately three percent of the total number (approximately 3,000,000 observations) of recorded winds (C. Nelson, personal communication). Also, winds of 30 knots and above are likely to adversely effect fishing. The percentages and distributions of windspeeds recorded by jig and bait vessels in the north and south coastal areas (Table 3) are similar and the incidence of winds over 30 knots is on the order of two or three percent in both areas.

To further investigate whether windspeeds reported by the albacore fleet are representative of wind conditions in the fishery area, the percent frequency of winds in the various speed classes reported by jigboats was compared with two additional data sources: FNOC computed winds and those tabulated in the U.S. Navy Marine Climatic Atlas of the World (Anon.,1977). Locations were selected from the latter two sources to approximate the previously mentioned four centers of activity in the fishery. Percent frequencies of windspeed from the three sources are listed in table 4 for comparison. For the comparison, the log and FNOC data were grouped similarly, but the Atlas frequencies only could be grouped into speed classes that approximated the others. Log data were extracted only for the regions north and south of 40N.

Table 4. COMPARISON OF PERCENT FREQUENCIES OF WINDSPEEDS IN SPEED CLASSES DURING MONTHS OF FISHING SEASONS. Data from jigboat fishing logbooks (Logs), FNOC computed winds (FNOC), and U.S. Navy Climatic Atlas (Atlas).

	WINDSPEED(KTS)				
	CALM	<10	10-20	20-30	>30
North coastal region					
Logs (N of 40N)	0	41	37	18	3
FNOC (50N 130W)	0	44	39	13	3
Atlas (#19)	0	33*	47*	18	4
South coastal region					
Logs (S of 40N)	0	48	36	18	3
FNOC (33N 125W)	0	48	46	5 *	<1
Atlas (#28)	0	45	41	6	<1
Pacific northwest offshore region					
FNOC	0	27	46	21	5 *
Atlas	0	31	43	13	13
Midway region					
FNOC	0	32	44	20	4 *
Atlas	0	26	43	16	15

The frequencies from the three sources generally are similar in most speed classes. Dissimilarities of apparent significance are noted in the table by means of asterisks and bracketing of the values; but no explanation for the differences is apparent. Some of the differences could be diminished by adjustment among adjacent speed classes (e.g., shifting 10 percentage points from the 20-30 to the 10-20 class for the log data in the south coastal region, or similarly shifting 8 points from the >30 to the 20-30 class for the Atlas data in the Pacific northwest offshore region). But there is no obvious reason for doing so. Thus, the sampling of wind observations reported by the albacore fleet appears to be generally comparable to data from the other references, except as noted; i.e.,they encounter and report windspeeds with a frequency essentially the same as merchant vessels.

Observations of stoppages of fishing due to winds in mid-season have been reported in the SWFC Albacore Bulletins and in the Annual Summary sections of the Annual Reports of the Pacific Marine Fisheries Commission. A sampling of noted times and areas of such occurrences was made for the 1984 season, and the computed windspeeds coincident with them were extracted from the FNOC environmental data records. These are combined in table 5. The windspeeds tabulated are those six-hourly FNOC values for the individual days at centrally located points within the areas of the fishery at which fishing was reported in either of the above media to be caused to stop due to high winds. It immediately becomes obvious that these windspeeds are significantly lower than most of those reported by fishermen responding to the questionaire. None of them were over 26 knots. A few examples of the stoppages are:(1) In the first three days of August between Morro Bay and Pt. Arena, 30 to 250 miles offshore, vessels were forced into port. The winds ranged from 17 to 24 knots (37N 123W). (2) At the end of August, 800 miles offshore of southern Oregon (45N,138W), boats left the area as winds increased. No winds above 15 knots are found in the FNOC records in late August; but winds of 15 to almost 18 knots occcurred there in the first days of September, and some records of winds up to 25 knots occurred there between the 6th and 14th of September. (3) Vessels fishing 300 to 350 miles west of the Columbia River left that area in the first few days of September because of rough seas and declining catches. Winds at 46N 130W in early September were below 15 knots except for two instances of 15 and 17 knots on the 8th of September. (4) In the second week of September, effort was reduced due to strong winds between Cape Blanco and Point Arena (42N 124W). Winds there on the 10th and 11th were 16 to 20 knots and between the 21 and 24th were 15 to 19 knots. (5) In late August and early September, from Pt Sur to San Francisco (37N 123W) fishing was affected by rough seas. Winds were of the range 15 to 22 knots at the noted location. (6) On September 21 winds from Point Arena to Guide Seamount increased and forced many boats to port, where they stayed until the 24th. At 37N 123W in that period winds were between 15 and 21 knots.

Table 5. COMPUTED WINDSPEEDS IN AREAS AND AT TIMES WHERE FISHING WAS REPORTED TO HAVE BEEN STOPPED DUE TO ADVERSE WINDS.

AREA: LAT. LONG.	Refer to number above	DATE 1984	COMPUTED WINDSPEED Knots
37 N 123 W	1	Aug 1-5,	17-23
"	5	Aug 30-31	15-22
"	6	Sep 21-24	15-22
42 N 124 W	4	Sep 10-11	16-19
45 N 138 W	2	Aug 29-Sep 8	15-24
46 N 130 W	3	early Sep	<15-17

In addition to the above incidents, daily logbook records maintained during chartered fishing trips during the past 12 years (1973-1984) by jigboats or longline vessels working jig lines were screened for notations of weather conditions adverse to fishing. Records noting rough or unworkable conditions are summarized in table 6. Among these 146 records, none was found of winds over 45 knots, and fishing was reported to have been adversely affected when winds were in the 20 to 40 knot range. Fishing did occur under conditions noted as "rough", "poor", etc. in windspeeds from 10 to 45 knots. No consideration was made of the geographic distribution of these reports.

TABLE 6. SUMMARY OF WINDSPEEDS RECORDED ON CHARTERED FISHING TRIPS DURING WHICH CONDITIONS WERE NOTED TO BE "ROUGH" OR "UNWORKABLE".

	WINDSPEED (KTS)		
	10-20	30-30	>30
ROUGH WHILE FISHING (n=130)	37	43	5
FISHING NOT POSSIBLE (n=16)	2	5	9

The above discussion makes it apparent that the regression used in figure 6 must be revised to account for the stoppage of fishing at windspeeds lower than those reported in responses to the questionaire. Therefore,data from the charter vessel day logs were treated similarly to those from the questionaire in deriving a regression relating windspeed values to their respective cumulative frequencies. The resulting equation is:

$$y = -61.53 + 4.87x$$

(Figure 7). This regression predicts that at winds of 20 knots, about 35 percent of the jig vessels would stop fishing. Similarly,at 25 knots, 60 percent would stop; at 30 knots, 85 percent would drop out; and at 40-45 knots, essentially all vessels would stop working.

Using the latter equation to compute the fishability index, the percent of lost fishing time per month due to the effect of wind, has been re-computed (Table 7). The results continue to show that, for the sample areas and times, wind is of minor consequence to fishing during the seasons of the two coastal fisheries. Lost fishing times (hypothetical) are of significant levels during months prior to the beginning of the seasons in all four areas, and they also are of significant levels at the ends of the seasons. The latter point is reinforced by reports made anecdotally in the Annual Reports of the Pacific Marine Fisheries Commission that the onset of winter storms, which occur with short time intervals between events, causes the fishing season to close. This particularly is common in the north coastal fishery, but proceeds to southern areas over time as adverse winds progress southward (Sund, 1984. 35th Annual Tuna Conference. Poster). It is not possible to distinguish whether the principal factor that precipitates the close of the season is the frequency of events (or equivalently, the low ratio of good to bad fishing weather) or the speed of the wind in any given event. In the two offshore areas of the fishery (Midway and Pacific Northwest offshore),levels of lost fishing time during months of the respective seasons at times are considerable (e.g. up to 28 percent).

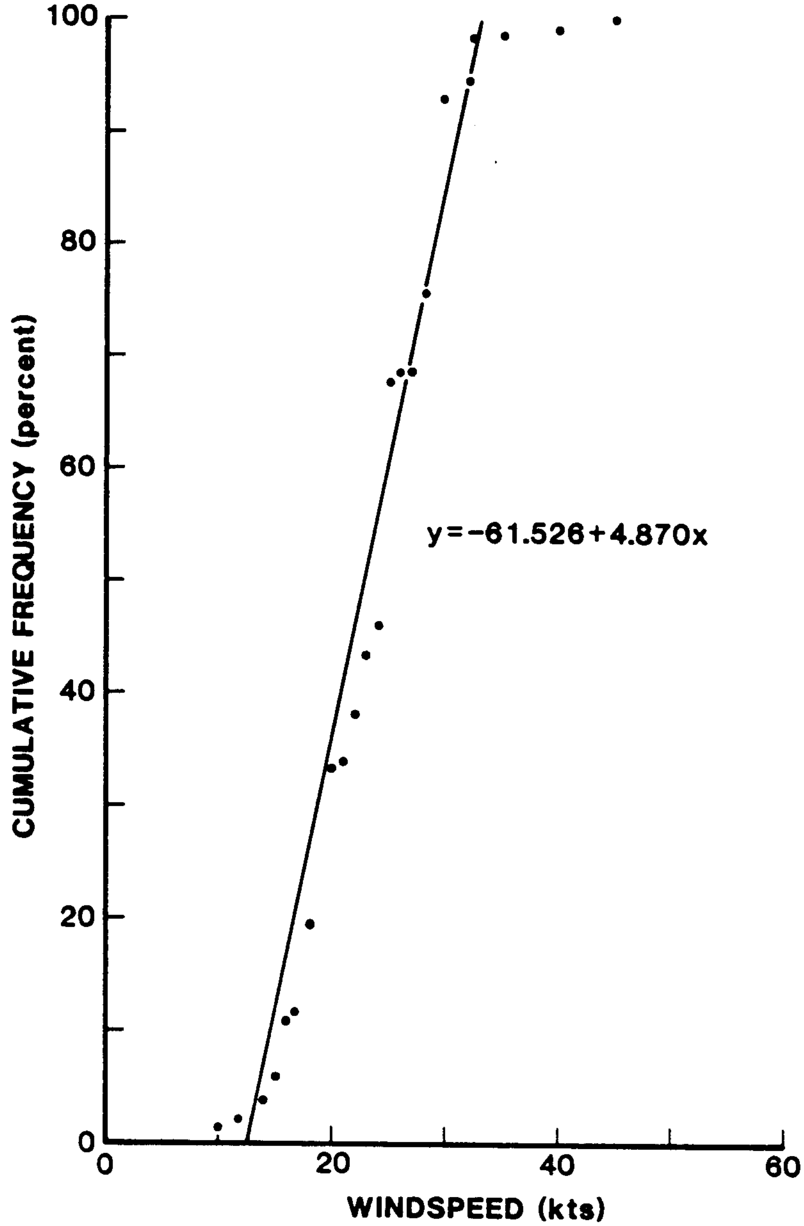

Figure 7. As per figure 6. Data from charter vessel daily log sheets.

Table 7. REVISION OF TABLE 2. PERCENT OF FISHING TIME LOST PER MONTH (HYPOTHETICAL) FOR SPECIFIED AREAS, 1979 TO 1983.

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
AREA: 33N 125W: South Coastal												
1979	10	7	5	9	8	8	5	3	5	3	0	8
1980	6	22	17	8	4	3	0	2	0	1	2	3
1981	12	6	9	9	9	17	2	4	4	1	5	6
1982	8	4	5	8	6	2	3	1	7	2	3	8
1983	14	9	9	11	7	4	5	1	3	3	7	10
					<......season........>							
AREA: 50N 130W: North Coastal												
1979	17	16	18	5	4	1	3	0	8	15	29	37
1980	20	27	7	25	7	3	1	6	10	16	27	31
1981	44	19	23	13	5	5	4	7	11	10	24	23
1982	17	12	10	10	11	1	5	3	4	10	11	16
1983	45	29	19	8	1	4	3	2	4	14	28	15
					<......season........>							
AREA: 45N 145W: Pacific northwest offshore												
1979	18	18	28	15	15	4	9	1	27	26	21	35
1980	28	27	24	41	23	2	7	1	12	24	28	26
1981	33	35	28	18	22	17	3	14	24	17	37	20
1982	34	13	32	28	15	5	7	8	11	28	29	40
1983	46	31	34	18	19	26	10	4	8	15	28	27
						<.....season....>						
AREA: 40N 170W: Midway												
1979	41	12	32	17	17	8	10	2	12	19	12	28
1980	37	29	33	40	19	5	20	9	16	28	30	25
1981	34	39	47	15	19	11	8	04	9	11	26	37
1982	27	25	14	10	17	7	12	2	10	25	24	31
1983	19	21	39	11	13	21	8	8	15	16	31	26
					<..season..>							

In summary, for the hypothetical cases illustrated, windspeed evidently is not a major factor on fishing in the coastal areas except during the beginning and ending months of the seasons. Windspeed is of greater significance in the two offshore regions. Within the seasons for those regions, the fishing time lost per month ranges from under five percent to about 28 percent. Thus, the use of the wind fishability index in fishery modelling studies should be an important factor for those offshore areas at least. Furthermore, the index values may indicate a different degree of influence if longer time series are used and/or if the geographic areas are defined differently.

SUMMARY AND CONCLUSIONS:

Fishing operations must cease at some "high" windspeed, and it may be supposed that large vessels should be able to fish at windspeeds higher than can small ones. Such relationships are evident from scatter diagrams and regressions computed from the data resulting from the questionaire. Windspeeds at which operations are cut off generally increase with vessel length. Differences in this relationship among four areas within the U.S. albacore fishery are evident, but there are insufficient data to test the differences statistically.

There is a consistent difference of about five knots in cut-off windspeeds for jigboats in "on fish" and "off fish" circumstances. This suggests that fishermen will "tough it out" in somewhat higher wind conditions when on fish than when not fishing.

None of the baitboats responding to the questionaire reported fishing at windspeeds above 35 knots. The" average" bait vessel (56 feet) stops fishing at about 25 knots of wind. Larger baitboats fish in higher winds than do smaller ones. No major difference is evident in the behavior of baitboats fishing the two coastal areas north and south of 40N.

Based on questionaire replies, both jigboats and baitboats can fish satisfactorily in winds up to about 20 knots. Baitboat fishing declines more in the 20 to 30 knot range of windspeeds than does jigboat fishing. Only two to three percent of fishing activity occurred at windspeeds above 30 knots for both vessel types. This approximates the frequency of occurrence for winds of those speeds in the climatic atlas and FNOC files.

There is no evidence from responses to the questionaire of an adverse effect of wind on jigboat fishing operations below windspeeds of about 20 knots. However, information from chartered vessel logs and from computed winds at times and places at which fishing was reported to have been stopped due to high winds indicates that fishing can be stopped by winds from as low as 10 to 15 knots up to 45 knots.

Computed winds for sample areas and times indicate that windspeeds have the potential for being a factor in determining fishable conditions within the four regions; and windspeed seems important regarding fishability as the end of the fishing season approaches in particular.

I have attempted to estimate the percent of jigboat fishing time that may be lost due to wind conditions. This is based on the frequency distribution of windspeeds at which jigboats reported that they stopped fishing due to adverse wind conditions. Examples of lost fishing time per month for the four regions of the fishery are given as a wind-fishability index. Because of the large and not completely understood disagreement between the index based on questionaire results (Table 2) and the one based on other sources resulting in adjusted index values (Table 7), it may be advisable to consider this index as a qualitative rather than quantitative measure of monthly variation in fishability. The adjusted index is preferred because it is based on a greater number of observations with less variability, and because it better conforms to what I understand to be a general impression that weather does at times significantly affect fishing effectiveness.

Environmental data sources used to construct the index tables are available for more extensive time periods and alternately defined areas. The index set presented here may thus be readily extended or modified for application to models of the fishery in order to investigate the influence of wind on catch or catch/effort, or to compare such influence among selected time and area strata.

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