Potential for Reduction in Widow Rockfish Bycatch in the Pacific Hake Fishery Using Bycatch Avoidance Areas

Brett Wiedoff and Steve Parker
ODFW, Marine Resources Program
Newport, OR

Situation

The bycatch of widow rockfish in all sectors of the Pacific hake fishery has been significant in scale but variable among sectors (Table 1). However, there has also been a dramatic time trend of significant reduction in widow rockfish bycatch since 1999, likely due to a combination of factors including lower hake OYs, lower widow rockfish relative abundance, outreach by managers to inform fishers of rationale for bycatch reduction, and active avoidance of widow rockfish habitat by the fleet. Indeed, each sector has shown dramatic and consecutive reductions to the all-time low catches that occurred in 2003.

Table 1. Summary of the of the US Pacific hake fishery through 2003. Weights are in metric tons.

Year	Hake US optimum yield (mt)	Widow RF US optimum yield (mt)	Mothership Widow RF bycatch (mt)	Catcher/ Processor Widow RF bycatch (mt)	Shoreside Widow RF bycatch (mt)
1999	232,000	4,981	48.00	101.00	191.74
2000	232,000	4,291	151.00	70.00	82.54
2001	190,400	2,260	29.19	139.71	43.60
2002	129,600	853	20.50	115.10	5.32
2003	148,200	832	0.69	11.56	8.97

In spite of these reductions, the overfished status of widow rockfish and associated low OYs have placed the PFMC in the position of restricting the hake harvest in an effort to constrain the potential for high bycatch of widow rockfish for all sectors. Analysis by the Oregon Department of Fish and Wildlife may aid in this discussion by providing an alternative to reducing the hake OY by focusing on minimizing the bycatch of widow rockfish more directly.

We believe that reducing hake OY is an inefficient and ineffective method for reducing widow bycatch for the following reasons. Widow rockfish bycatch is rare, with almost all of the widow rockfish captured occurring in only a handful of tows. These high-bycatch tows are essentially random, so within a season there is no relationship between the amount of hake caught and the amount of widow rockfish encountered. Although the probability of a high-bycatch tow increases as more tows are conducted, only a few high-bycatch tows could easily exceed the expected catches for the fishery. One of the only predictable aspects of widow rockfish bycatch is where it occurs. On a gross scale, it occurs within the RCA, namely along rocky areas of the shelf break. We propose to use this geographic pattern in bycatch to predictably minimize bycatch in the future hake fishery.

Approach

We have taken a GIS approach to identifying locations along the coast in each sector that tend to show high bycatch rates. We used data from 1999-2003 from each sector. For each sector, catch of hake and widow rockfish from each tow plotted as low, med and high bycatch rates using logbook tow locations. Tows with zero bycatch are also shown so that the total distribution of fishing effort is visible. For shoreside sector trips with multiple tows, the bycatch rate was calculated for the trip and then indicated as low, med, and high for every tow of the trip from logbook data. This procedure was conducted for catcher processors (CP), mothership (MS) and shoreside (SS) sectors. Note however that because bycatch has decreased dramatically, most of the high-density areas (areas with yellow and red symbols) are made mainly tows from earlier years. None-the-less, these represent areas that show high bycatch rates through multiple years, and so are useful in defining areas where widow rockfish bycatch is more probable.

Several fishery characteristics are obvious in the GIS plot (Figure 1). First, the SS sector typically fishes shallower than the CP sector, but overlaps well with the MS sector. All sectors overlap almost completely in areas where the shelf or shelf break is especially narrow (*e.g.* Heceta Bank). Secondly, the CP fishery tends to fish the full latitudinal range from 42°N to 48°N, though the focus of their effort was to the north in 99-01 and to the south in 02-03.

We identified areas where widow bycatch was likely regardless of sector, and created boxes surrounding them for each of enforcement and compliance. We identified 4 boxes coastwide (red boxes in Figure 1). We then eliminated the tows within a given box, recalculated the mean annual bycatch rate for each sector and expanded for a simulated hake allocation of 91,350 mt SS, 73,950 mt CP and 52,500 mt MS (based on 2004 allocation). The bycatch rate was determined using the same methodology developed by the GMT in March for the 2004 hake allocation (40%: '03, 30%: '02, 20%: '01, 10%: '00).

Results show that much of the widow bycatch can be isolated in these areas (Table 2-attached). The locations of high bycatch were different for each sector, but significant reductions could be made with any box. Because little difference in bycatch would be expected if vessels from any sector fished in these areas, we recommend that these areas be considered high bycatch areas for the fishery, not for any specific sector. The resulting decrease in widow rockfish bycatch is shown in Table 3. Of course, closing the entire RCA

Table 3. Estimated bycatch of widow rockfish (mt) in the Pacific hake fishery in 2004 after closure of areas with historically high bycatch rates.

Option	Shoreside	Mothership	Catcher-Processor	Total Estimated Widow	% Reduction
No Closure	25.90	55.07	391.41	472.38	
Box 1 Only	24.96	10.06	130.82	165.84	65%
Box 2 Only	24.21	19.87	74.59	118.67	75%
Box 3 Only	29.60	20.55	62.62	112.77	76%
Box 4 Only	25.81	18.54	148.20	192.55	59%
Entire RCA	6.77	10.20	27.58	44.55	91%

to midwater fishing had the largest impact, similar to the results in the poster presentation by Wiedoff and Parker (2004). Also note the relatively minor differences in hake bycatch rate expected after exclusion of any area. Therefore, the relative effectiveness of the closure areas is due mainly to the avoidance of widow rockfish bycatch, not to changes in the hake catch rate.

Risks

One potential risk for closing some areas to fishing is that of increasing bycatch of some other species as the fishing effort shifts to other areas. Bycatch of other species is also patchy in time and space (Figure 2). Although not analyzed here, bycatch of yellowtail rockfish occurs in similar areas with widow rockfish, so some overall decrease in yellowtail rockfish bycatch would be expected. Bycatch of young sablefish is more dependent on large year classes which analysis suggests is predictable a year in advance and can be addressed in that way.

Our work indicates that the mean rate of hake catch/h is the same inside and outside bycatch avoidance areas and so no increase in fishing time should result from closing any or all bycatch avoidance areas. Aside from changes in where they can fish and changes in travel time, we do not see a pronounced effect of this approach on fishing efficiency.

Of course there is always the risk of encountering high bycatch of widow rockfish even when fishing outside the bycatch avoidance areas. However, this risk is less when fishing outside bycatch avoidance areas than if fishing anywhere with a lower hake OY.

The bycatch rates presented do not incorporate the variation in bycatch for each sector. Therefore, small changes in the rate, or estimated catch should not be viewed as significant. Also, in 2002 the CP sector experienced one large tow that accounts for almost 80 of its bycatch. The presence of this tow dramatically changes the bycatch rates for that year and the corresponding predicted rate. We excluded that tow, but show what the average 2002 rate would have been in the margin with an asterisk.

Recommendations

- Identification and avoidance of bycatch avoidance areas allows the fishery to avoid known areas of high widow bycatch using midwater trawl gear. The resulting decrease in widow rockfish bycatch is fairly predictable and should not be impacted by the scale of the hake OY.
- We recommend that the number of closure areas be the minimal number needed. The number of bycatch avoidance areas chosen is up to the council process, but because of enforcement issues and the likelihood that the time-trend in bycatch is a major factor influencing bycatch.
- Bycatch avoidance areas chosen should apply to all hake sectors because fishing in an identified zone by any sector is likely to produce higher bycatch.

Table 2.

Calculations of estimated widow bycatch for the Pacific hake fishery in 2004 based on a weighted widow bycatch rate (kg/h) and weighted hake bycatch rate (mt/h). Note one large (80 mt) CP tow in 2002 severely changes bycatch rates, this tow is exluded from analysis, though the real average is given as a note.

Option		Shoreside			Mothership			Catcher-Processor			Total Widow
NO CLOSURES	2004 Allocation (mt)	N=1598		91,350	N=4290		52,500	N=3626		73,950	
	Year	Weighting	Widow (kg/h)	Hake (mt/h)	Weighting	Widow (kg/h)	Hake (mt/h)	Weighting	Widow (kg/h)	Hake (mt/h)	
	2000	10%	31.167	42.489	10%	93.283	26.926	10%	49.103	25.639	
	2001	20%	35.528	35.547	20%	40.805	29.277	20%	636.273	50.079	
	2002	30%	3.712	47.187	30%	84.855	38.161	30%	560.982	55.77	
	2003	40%	7.781	63.625	40%	17.768	69.307	40%	47.552	77.622	
	Total catch rate		14.45	50.96		50.05	47.72		319.48	60.36	
	Hours fishing needed			1792.43			1100.19			1225.16	
	Estimated Widow (mt)		25.90			55.07			391.41		472.38

Option		Shoreside			Mothership			Catcher-Processor			Total Widow
CLOSE BOX 1	2004 Allocation (mt)	N=1569		91,350	N=3512		52,500	N=3296		73,950	
	Year	Weighting	Widow (kg/h)	Hake (mt/h)	Weighting	Widow (kg/h)	Hake (mt/h)	Weighting	Widow (kg/h)	Hake (mt/h)	
	2000	10%	26.623	41.591	10%	13.19	25.627	10%	13.474	27.056	
	2001	20%	36.018	35.182	20%	15.731	28.969	20%	156.359	48.323	
	2002	30%	3.03	47.269	30%	12.658	36.802	30%	236.791	56.071	
	2003	40%	7.781	63.625	40%	2.421	71.937	40%	7.822	77.928	
	Total catch rate		13.89	50.83		9.23	48.17		106.79	60.36	
	Hours fishing needed			1797.30			1089.85			1225.09	
	Estimated Widow (mt)		24.96			10.06			130.82		165.84

Option		Shoreside			Mothership			Catcher-Processor			Total Widow
CLOSE BOX 2	2004 Allocation (mt)	N=1535		91,350	N=4212		52,500	N=3471		73,950	
	Year	Weighting	Widow (kg/h)	Hake (mt/h)	Weighting	Widow (kg/h)	Hake (mt/h)	Weighting	Widow (kg/h)	Hake (mt/h)	
	2000	10%	32.166	43.212	10%	51.874	26.867	10%	20.99	25.646	
	2001	20%	31.644	35.147	20%	16.096	29.277	20%	197.543	41.338	
	2002	30%	3.844	47.699	30%	27.695	38.161	30%	47.953	55.705	*238.784
	2003	40%	7.607	65.458	40%	3.356	69.307	40%	7.76	77.622	
	Total catch rate		13.74	51.84		18.06	47.71		59.10	58.59	
	Hours fishing needed			1762.03			1100.32			1262.11	
	Estimated Widow (mt)		24.21			19.87			74.59		118.67

Option		Shoreside			Mothership			Catcher-Processor			Total Widow
CLOSE BOX 3	2004 Allocation (mt)	N=1189		91,350	N=4068		52,500	N=3207		73,950	
	Year	Weighting	Widow (kg/h)	Hake (mt/h)	Weighting	Widow (kg/h)	Hake (mt/h)	Weighting	Widow (kg/h)	Hake (mt/h)	
	2000	10%	27.929	40.419	10%	49.108	26.854	10%	16.772	23.533	
	2001	20%	35.298	37.78	20%	15.828	29.322	20%	192.689	49.669	
	2002	30%	4.598	43.345	30%	25.514	37.214	30%	25.239	55.666	*229.824
	2003	40%	10.98	59.03	40%	2.876	58.541	40%	7.618	77.606	
	Total catch rate		15.62	48.21		16.88	43.13		50.83	60.03	
	Hours fishing needed			1894.70			1217.24			1231.90	
	Estimated Widow (mt)		29.60			20.55			62.62		112.77

Option		Shoreside			Mothership			Catcher-Processor			Total Widow
CLOSE BOX 4	2004 Allocation (mt)	N=1539		91,350	N=3804		52,500	N=3249		73,950	
	Year	Weighting	Widow (kg/h)	Hake (mt/h)	Weighting	Widow (kg/h)	Hake (mt/h)	Weighting	Widow (kg/h)	Hake (mt/h)	
	2000	10%	31.537	42.811	10%	50.404	26.669	10%	20.838	25.639	
	2001	20%	37.311	36.502	20%	9.208	30.369	20%	217.762	55.605	
	2002	30%	2.81	47.652	30%	27.695	38.161	30%	245.919	56.645	
	2003	40%	8.061	65.248	40%	3.658	67.41	40%	9.416	76.967	
	Total catch rate		14.68	51.98		16.65	47.15		123.18	61.47	
	Hours fishing needed			1757.53			1113.40			1203.12	
	Estimated Widow (mt)		25.81			18.54			148.20		192.55

Option		Shoreside			Mothership			Catcher-Processor			Total Widow
CLOSE RCA	2004 Allocation (mt)	N=802		91,350	N=1432		52,500	N=1693		73,950	
	Year	Weighting	Widow (kg/h)	Hake (mt/h)	Weighting	Widow (kg/h)	Hake (mt/h)	Weighting	Widow (kg/h)	Hake (mt/h)	
	2000	10%	31.304	42.292	10%	43.22	22.451	10%	15.759	25.99	
	2001	20%	4.446	35.534	20%	7.045	30.064	20%	60.575	43.957	
	2002	30%	0.14	53.898	30%	7.089	34.415	30%	23.075	40.895	*998.662
	2003	40%	0.236	71.378	40%	1.423	62.028	40%	5.228	93.061	
	Total catch rate		4.16	56.06		8.43	43.39		22.70	60.88	
	Hours fishing needed			1629.60			1209.86			1214.62	
	Estimated Widow (mt)		6.77			10.20			27.58		44.55

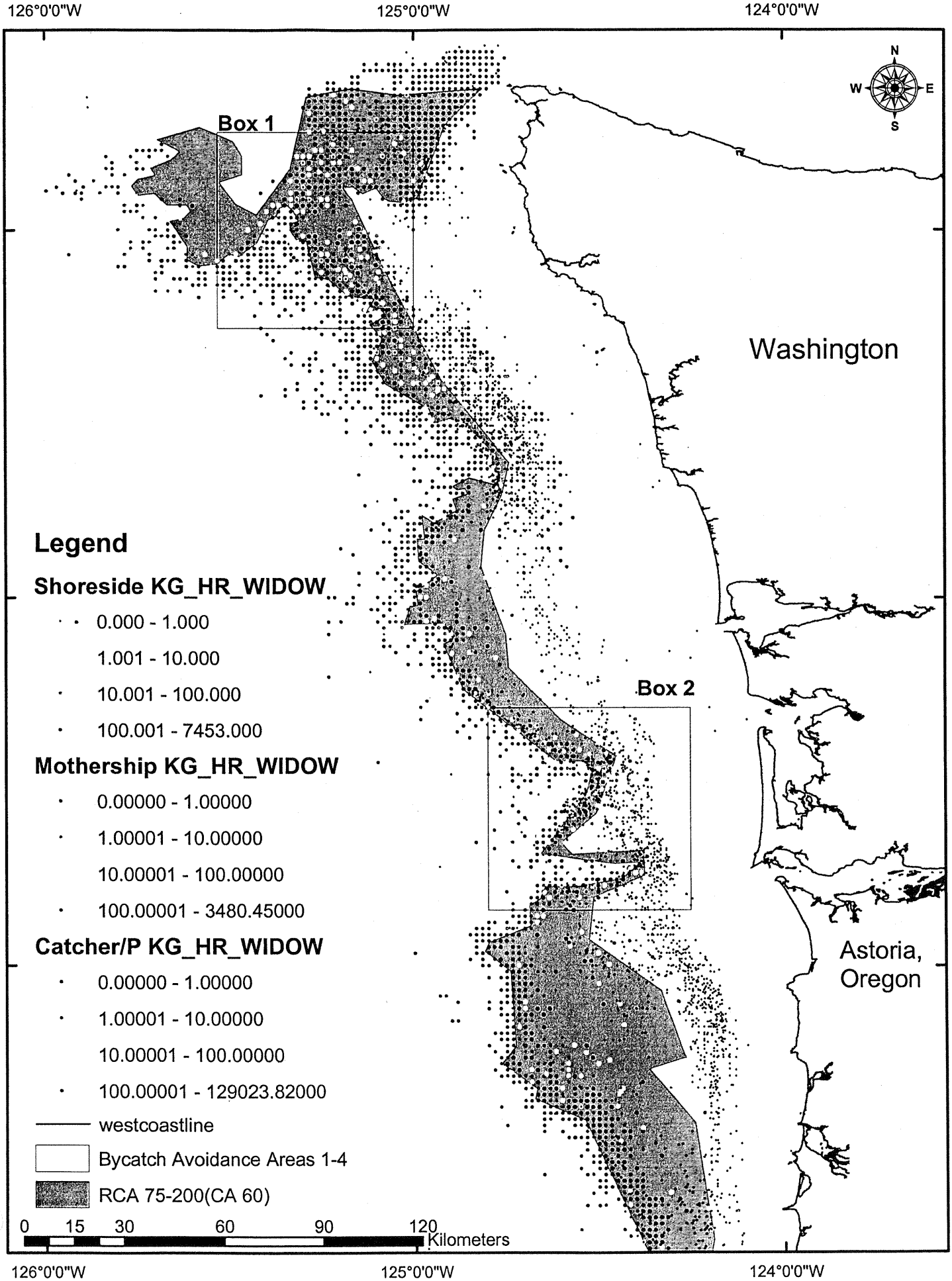


Figure 1. Tow distribution for Pacific Hake Fishery 1999-2003. Rates are kg of widow rockfish/hr towed. 5

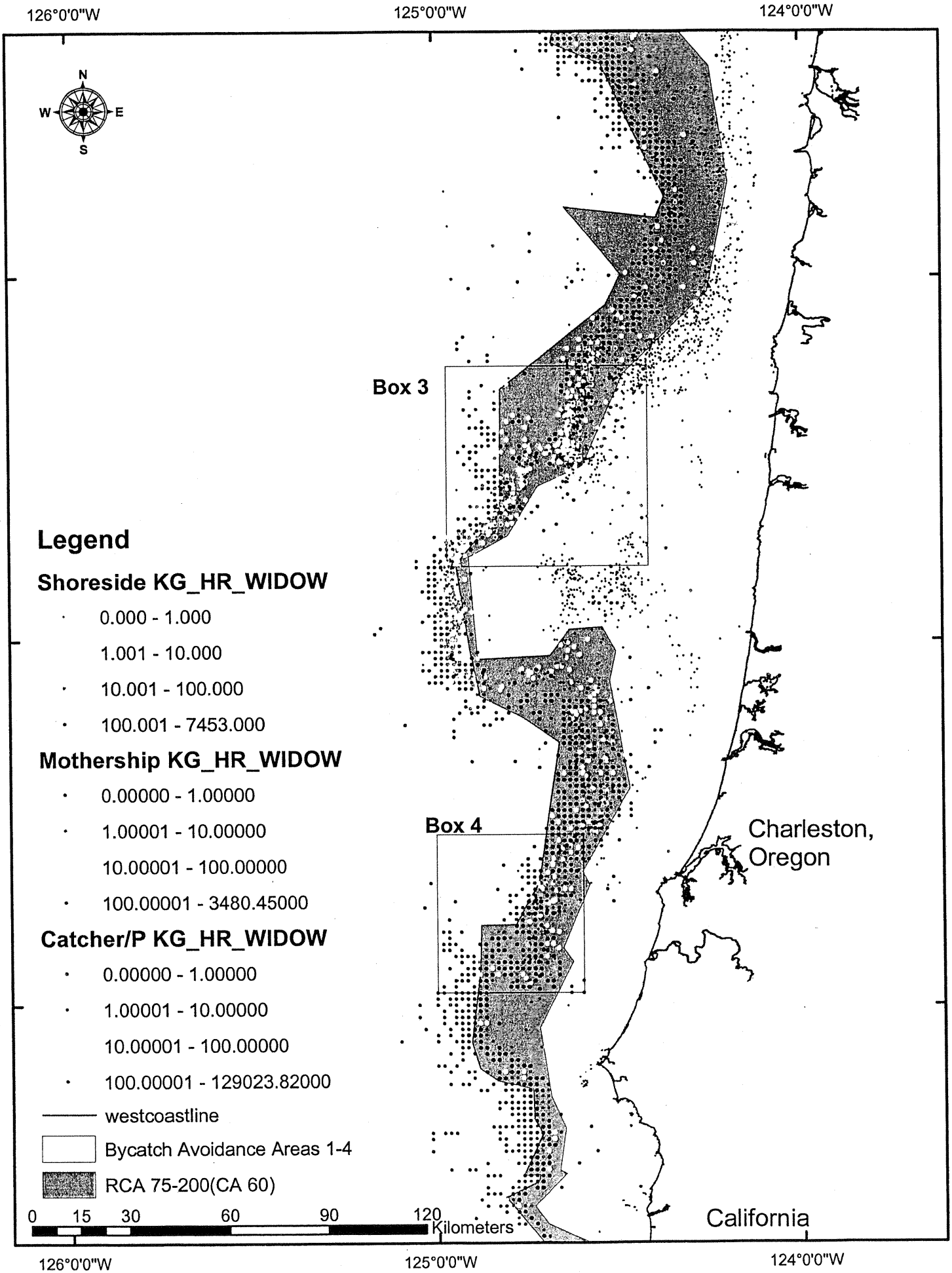
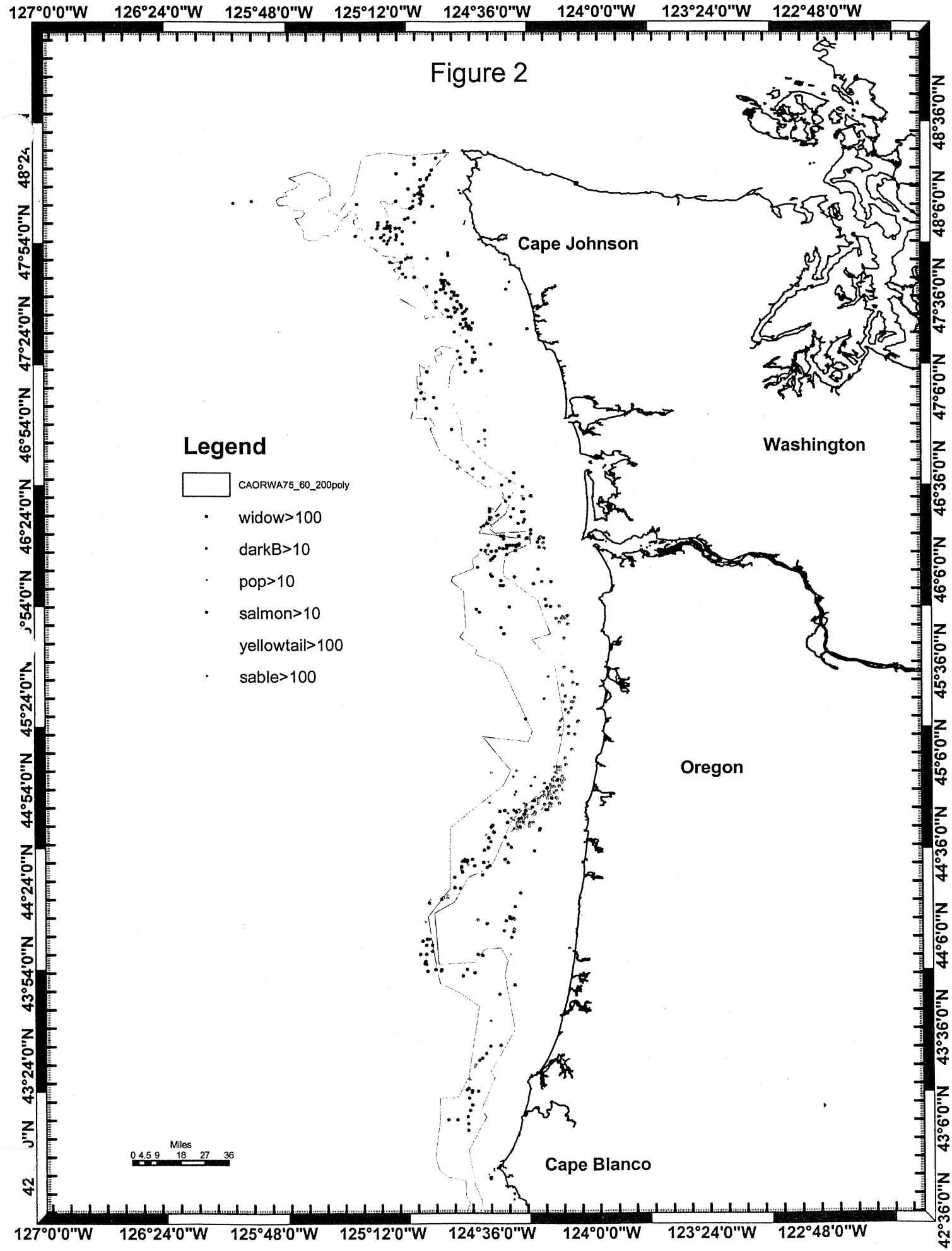


Figure 1a. Tow distribution for Pacific Hake Fishery 1999-2003. Rates are kg of widow rockfish/hr towed.

Figure 2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