

**Further analysis of salmon associated catch
Ray Hilborn January 2008**

Executive Summary

- Several sources of data indicate that that for every 100 salmon caught by trolling, about 1-2 non-target fish is caught.
- If we assume that all of the chinook fishing and associated catch take place within the NC coast, the estimated associated catch is about 6,000-12,000 fish per year.
- Using two independent estimates of non-target fish abundance, even if we assume that the associated catch rate is 10 times higher (10 fish associated catch per 100 chinook), the exploitation rate on non-target species due to associated catch is less than 1%.
- A 1% exploitation rate on any species under consideration would have no population level impact.
- I conclude that salmon trolling should be considered the highest level of protection.

Associated catch rates

I have done some further analysis of the impact of associated catch in salmon fisheries and how this associated catch would affect non-target species.

In previous discussions we have used state logbook data on landings which are shown in table 1.

Table 1. Commercial and recreational logbook data for the NC coast study area
Recreational Trips targeting salmon with Hook and Line (2000-2007)

Species	# of Fish	% Total	Estimated lbs	% Total
Salmon	53,228	95.0%	425,824	97.8%
Rockfish	1,584	2.8%	3,168	0.7%
Other	1,240	2.2%	6,200	1.4%
Total	56,052	100.0%	435,192	100.0%

* Average salmon catch of 8lbs

**Average rockfish catch of 2lbs

***Average other catch of 5lbs

Commercial Trips targeting salmon

Species	Lbs	% of Total	Estimated # of fish	% Total
Salmon	15,557,819	99.82%	1,944,727	99.30%
Other	27,297	0.18%	13,648	0.70%
Total	15,585,116	100.00%	1,958,375	100.00%

Species	# of Fish	% Total	Estimated lbs	% Total
Salmon-C	1,944,727	95.9%	15,557,819	96.5%
Salmon-R	53,228	2.6%	425,824	2.6%
Rockfish-R	1,584	0.1%	3,168	0.0%
Other-C	27,297	1.3%	136,485	0.8%
Other-R	1,240	0.1%	6,200	0.0%
Total	2,026,836	100.0%	16,123,296	100.0%

In previous discussions we used the commercial data which is just trolling, whereas the recreational data include both trolling and mooching, and there are questions about how sport logbooks recorded mixed trips where they commonly begin with a salmon targeting trip and then switch to rockfish later in the day.

Subsequently Don Pearson and Steve Ralston at NOAA have done an analysis of commercial salmon landings in their report “landed rockfish by-catch of the commercial salmon fishery”. Their report shows very low associated catch rates for commercial trolling. Table 2 shows the results from their analysis as the lbs of rockfish landed per lb of salmon. These data are split by port complex.

Table 2. Lbs of rockfish landed per lb of salmon from Pearson and Ralston’s analysis. The last two rows show calculations of the average lbs of salmon for year and finally the lbs of rockfish for the three ports primarily fishing in the NC coast (for years 2000-2005).

year	port_complex							
	Crescent City	Eureka	Fort Bragg	Bodega Bay	San Francisco	Monterey	Morro Bay	Santa Barbara
1997	-	0.059	0.028	0.041	0.014	0.002	0.067	0.086
1998	-	0.001	0.199	0.119	0.012	0.009	0.035	0.007
1999	0.004	0.006	0.019	0.002	0.002	0.003	0.009	-
2000	0.072	0.007	0.002	0.002	0.002	0.003	0.003	-
2001	0.008	0.001	0.002	0.001	0.001	0.003	0.002	-
2002	0.002	0.001	0.002	0.000	0.000	0.001	0.002	-
2003	0.004	0.004	0.000	0.000	0.001	0.001	0.006	-
2004	0.000	-	0.000	0.000	0.000	0.001	0.002	-
2005	-	-	0.000	0.000	0.000	0.005	0.003	-
average lbs salmon				910,155	1,771,968	1,072,658		
average lbs rockfish per year 2000-2005				478	1,302	2,418		

We can see from Table 2 that the lbs of rockfish landed by the commercial salmon fishery per year is very small, (roughly 4,000 lbs per year in the three key ports) and this is consistent with all other sources of data that salmon trolling catches insignificant numbers of other species. I used only the years between 2000 and 2005 because Pearson and Ralston report that for 1997-1999 they believe that a few boats were reporting non salmon trolling trips that included large rockfish associated catches. Furthermore only 16% of the species caught were nearshore species likely to benefit from MPAs in state waters. Thus we can conclude that commercial trolling has no measurable impact on the rockfish communities in potential MPAs in state waters.

The catch of associated species while sport trolling has several sources of information. Sport charter boat operators and individual fishermen say that associated catch while trolling is rare.

I also have a letter (attached as appendix I), from Mr. Dennis McKiver, a marine warden for the Department of Fish and Game in Mendocino County. Mr. McKiver says that in his 20 years of

experience enforcing salmon trolling activities, that in less than 20 meters of water he has observed less than 1% associated catch rate and there is no associated catch in deeper waters.

The logbooks do have columns for discarded fish, and there are undercover enforcement activities that charter operators believe they need to maintain reliable records. Table 3 shows the logbook results from the State analysis for fishing at depths <50 meters, > 50 meters and all data.

Table 3a. Charter boat logbook results for depths less than 50 m.
trolling only <50m for kept and released

	all salmon	other	% other
2001	6,337	753	11%
2002	9,138	545	6%
2003	6,265	589	9%
2004	17,091	914	5%
2005	16,874	2,359	12%
2006	11,158	5,213	32%

Table 3b. Charter boat logbook results for depths greater than 50 m.

	all salmon	other	% other
2001	7,394	103	1%
2002	20,698	219	1%
2003	20,804	181	1%
2004	26,495	57	0%
2005	13,197	96	1%
2006	15,903	409	3%

Table 3c. Charter boat logbook results for all depths.
trolling only for all data

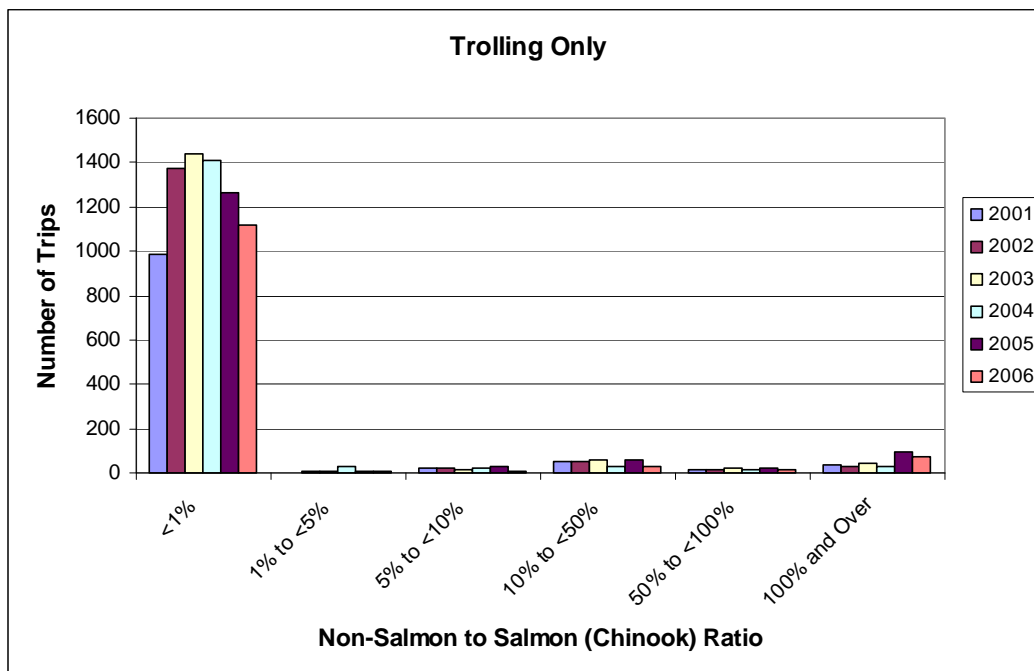
	all salmon	other	% other
2001	17,306	1,146	6%
2002	37,965	800	2%
2003	32,773	788	2%
2004	44,034	971	2%
2005	30,600	2,473	7%
2006	27,353	5,622	17%

The key result from this analysis is that the deep trolling has very little associated catch of other species, while these data show higher rates for shallow trolling. We also have very limited data from observed trips shown in table 4. Again we see little if any associated catch when trolling deep and higher rates when trolling shallow. Note that the total sample size here is very limited.

Table 4 . Summary of CPFV trips observed in the NCCSR using trolling as the fishing mode, 2003 to 2006. Data was queried from the CRFS database. Trips were categorized by depths less than 50m and greater than 50m.

Depth Category Observed Depths	< 50 m			> 50m		
	9.14 to 45.72 meters (30-150 feet)			51.82 to 243.84 meters (170-800 feet)		
Species Caught	Total # Observed	Total % Observed	% Trips Observed	Total # Observed	Total % Observed	% Trips Observed
Chinook	810	82.82	100	1114	95.54	97.73
coho	24	2.45	15.38	40	3.43	34.09
Pacific mackerel	83	8.49	7.69	0	0.00	0
black rockfish	37	3.78	15.38	0	0.00	0
lingcod	10	1.02	5.77	0	0.00	0
striped bass	5	0.51	5.77	0	0.00	0
blue rockfish	4	0.41	5.77	0	0.00	0
thresher shark	3	0.31	1.92	0	0.00	0
spiny dogfish	2	0.20	1.92	3	0.26	4.55
jack mackerel	0	0.00	0	4	0.34	4.55
Pacific hake	0	0.00	0	2	0.17	2.27
Pacific sardine	0	0.00	0	2	0.17	2.27
steelhead trout	0	0.00	0	1	0.09	2.27
Total # Fish Caught	978			1166		
# of Trips Observed	52			44		

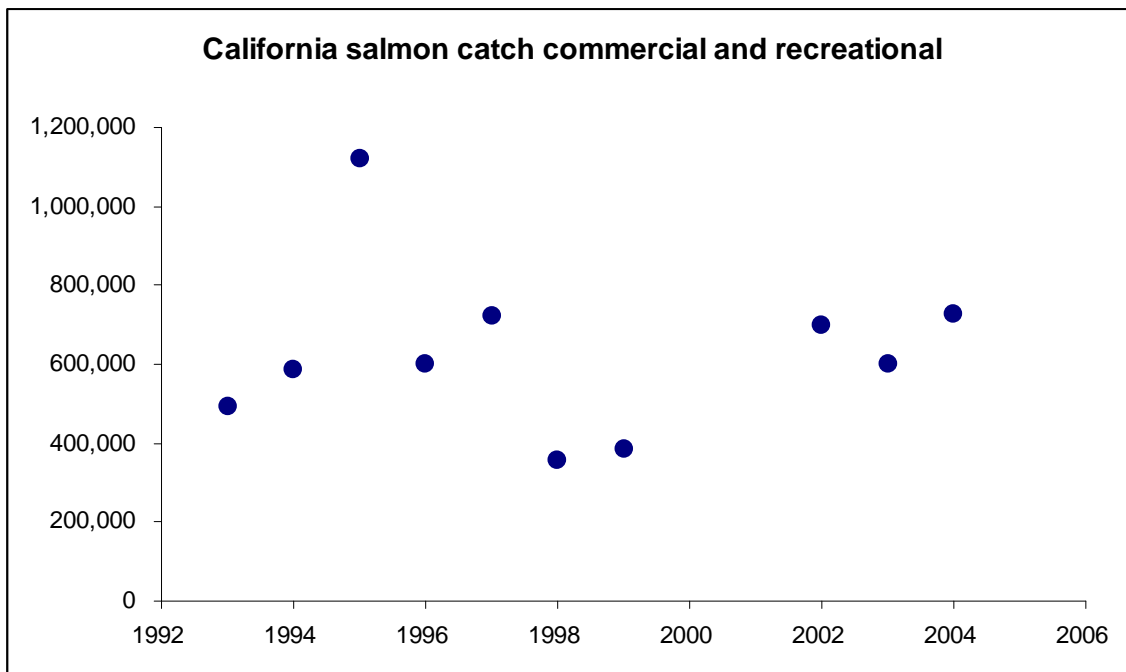
The catch rates of associated species from the logbook data when fishing at less than 50 meters is much higher than the fish and game warden (Mr. McKiver) charter boat operators and experienced fishermen believed to be true. Fish and Game staff cautioned that the data may be affected by trips that were recorded as trolling and after some time switched to bottom fish. To examine this, Fish and Game staff looked at the associated catch rates by individual trip and found that most trips reported almost no associated catch as seen in the figure below. Most trips report less than 1% associated catch to chinook, but a few trips report high catch of associated species. These few trips account for the majority of associated catch, and it seems very likely that these trips represent mixed trips that included targeted bottom fishing but were recorded as troll only. It is difficult to imagine how a few individual trips could have such anomalous catch rates of associated species when fishing with the same kind of gear in the same kind of habitat.



Salmon Catch

Salmon catch data for California were obtained from the North Pacific Anadromous Fisheries Commission (NPAFC) web site. Below is a graph of total commercial and sport catch for California from 1993 to 2004. No data were available from this source for 2000 or 2001. The average over this period was 628,953 fish. Chinook dominate this catch, with coho and steelhead the next most important. I have not obtained a breakdown of the catch between commercial, recreational greater than 50 meters and recreational less than 50 meters. From the numbers I do have available it appears that perhaps 2/3 of the catch is commercial (based on the total landings from the NPAFC) and the total pounds in the Pearson and Ralston report. Of the recreational catch, from the logbook analysis it appears that slightly more than 50% is in the shallower waters. The evidence is strong that commercial trolling and recreational trolling at depths greater than 50 meters have associated catch rates less than 1%. If we use a 5% associated catch rate for salmon trolling in depths less than 50 meters, and that 20% of the total salmon catch is taken in those depths, then we have an estimated overall associated catch rate of 1-2%.

If we go to the extreme and assume 20% associated catch rates for salmon trolling less than 50 meters, we end up with an overall associated catch rate of roughly 4%.



I have then calculated the impact over a range of assumptions of associated catch rates and fish abundance.

I have two approaches to estimating fish abundance. In both cases I assume that all of the chinook fishing takes place in the NC Coast region.

Field et al (2006) provide an estimate of the abundance of all the major trophic components of the California Current ecosystem. Rockfish, bottomfish, and a few related species that would make up any likely associated catch constituted about 26,000 kg/square kilometer in 1960. Allowing for a 50% depletion of this group as a whole to present, that is 13,000 kg per square km.

Table 5. Estimated associated catch rates, using the Field estimate of non-target fish abundance for associated catch rates of 1%, 5% and 10%.

Total chinook catch	628,953	628,953	628,953
associated catch rate	1%	5%	10%
associated catch	6,290	31,448	62,895
Weight per fish	2	2	2
lbs associated catch	12,579	62,895	125,791
State waters area km ²	2,000	2,000	2,000
lbs/km ²	6.3	31.4	62.9
fish/km ²	3.1	15.7	31.4
Density of potential by catch (kg/km ²)	13,000	13,000	13,000
density of potential bycatch (lbs/km ²)	28,600	28,600	28,600
Annual exploitation rate	0.022%	0.110%	0.220%

We see here that even if the associated catch rate is 10% of salmon landings, the exploitation rate on non-target species would be negligible.

A second approach is to take the estimated biomass of key species likely to benefit for which assessments are available (lingcod, black rockfish and bocaccio) from the NOAA stock assessments for the most recent years available. These total 61,000 tons, at an average weight of 1 kg per fish, that means there are roughly 61 million lingcod, bocaccio and black rockfish. Obviously the associated catch consists of many other species as well so this is generally a conservative estimate. Next I assume that these stocks are found within 10km of a 2000 km coastline so there are 20,000 km² of potential habitat. This is grossly conservative for bocaccio, which is found over a much smaller portion of the coastline. But the estimate is therefore about 3,000 fish per square km. Under these assumptions the exploitation rates are again negligible.

Table 6 Estimated associated catch rates, using estimated abundance for 3 species for associated catch rates of 1%, 5% and 10%

Total chinook catch	628,953	628,953	628,953
associated catch rate per chinook	1%	5%	10%
associated catch	6,290	31,448	62,895
Current biomass (tons)			
Lingcod	29,416	29,416	29,416
Bocaccio	10,752	10,752	10,752
black rockfish			

	21,300	21,300	21,300
Total	61,468	61,468	61,468
Area km ²	20,000	20,000	20,000
Average associated catch weight in kg	1	1	1
Number of associated catch fish	61,468,000	61,468,000	61,468,000
Associated catch Fish/km	3,073	3,073	3,073
exploitation rate	0.102%	0.512%	1.023%

Summary

All of the data available suggest that associated catch rates for salmon trolling are low, probably 1-2%. I have used two methods to estimate abundance of potential associated catch species, and across a very broad range of assumptions there is no case that can be made that troll associated catch at any depth would affect the populations of non-target species.

Appendix I letter from Mr. Dennis McKiver

Ms. Susan Golding, Chair
MLPA Blue Ribbon Task Force
1416 Ninth St., Suite 1311
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December 10, 2007

Dennis McKiver
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Phone: 707-962-9101

Dear Chair Golding,

I have been living, working and sport fishing on the Central California Coast between Monterey and Fort Bragg since 1983. Since June of 1986, I've been employed as a Fish and Game Marine Warden. I am currently working in Mendocino County as the Coastal Lieutenant Supervisor. However, I am writing this on my behalf as a concerned sport fisherman. This is my opinion and not necessarily the position of the Department of Fish and Game.

Between 1986 and 1998 I worked out of Half Moon Bay and San Francisco as a marine patrol boat boarding officer between Pigeon Point and Point Arena. Since 1998 I have worked as a marine warden off the Mendocino County Coast between Gualala and Shelter Cove. My work duties included checking the catches of thousands of sport fishermen each year, both at sea and at the docks. Most of the sport fishermen I check are sport salmon fishermen.

I very seldom see sport fishermen catching rockfish while targeting salmon. When I do see people who have taken rockfish while fishing for salmon, it's usually when they are fishing over rocky reefs in waters less than 10 fathoms (20 meters), or while drifting bait (mooching) The few rockfish I see taken while trolling for salmon are almost always blue rockfish which hang out near the surface. These fish are only caught when a person is trolling over rocky reefs, which is the minority of the time and can be released without harm do to the shallow depth. When fishermen do troll over rocky reefs, by nature, they tend to fish far up from the bottom, so they don't snag their weights on rock outcroppings. In my professional experience I would estimate the percentage of persons catching any rockfish or other fish, while targeting and trolling for salmon in less than 10 fathoms (20 meters), is less than one percent. In water deeper than that, in my experience the incidental take is near zero.

Sincerely,



Dennis McKiver