A White Paper on the History of the Commercial Fishery for Skates in Washington (Draft 3/20/2019 am)

Introduction

The references with insights into Washington's fishery for skates beyond landing data is limited. Some of this is found only as a casual mention in a table as a footnote or a single sentence. Other species like Petrale, halibut, sablefish or lingcod with long history of fresh or frozen markets have an abundance of information available in reports, research papers and memos usually due to concern about declines in catch. While information about amount landed is available, breakout by species is the primary object of the research is not. Meal, fertilizer, oil markets by their nature are aggregates of species and do not lend themselves to breakouts by genus and species unless sampled by fisheries agents. Even accurate amounts landed are obscured by the inclusion in the market term "scrap fish". This is further complicated by selective discard of the catch. The history of skate in Washington is multicultural and found in tribal and non-tribal cultures.

First nations have included skates in their diets. It has been documented that Coastal and Salish tribes made skate a part of their diet. Detailed descriptions of the role of skate in native diets can be found in the website Traditional Animal Foods of Indigenous Peoples of Northern North America. The contributions of wildlife diversity to the subsistence and nutrition of indigenous cultures by Harriet V. Kuhnlein and Murray M. Humphries at. (http://traditionalanimalfoods.org/fish/saltwater/page.aspx?id=6441).

Early use by Europeans of skates was limited. In the early 1800's in the UK (Ellis et.al. 2010) reports that skates were used as "pot bait", and food for fishermen's families. White Skate were exported to France as a food item. The earliest use I could find in United States was in in a United States Fisheries Commission report (Bowers 1904), where they were dried on racks where they were (Figure 1) and then ground up for fertilizer. This practice must have started much earlier than 1902. Skate livers yielded low grade oil and their skin being used for grips in sword handles along with other species of elasmobranchs even up to today (Figure 2).

Figure 1 Skate being dried for fertilizer in 1902 outside Provincetown Massachusetts (Bower 1904)

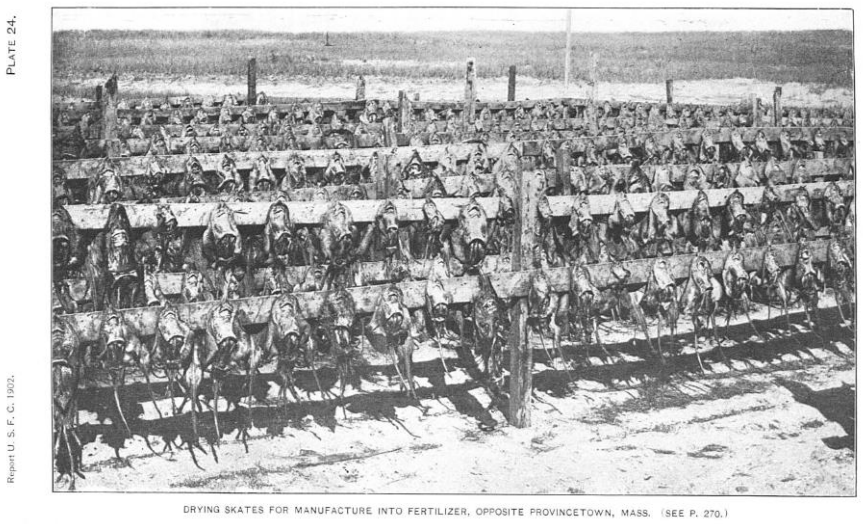
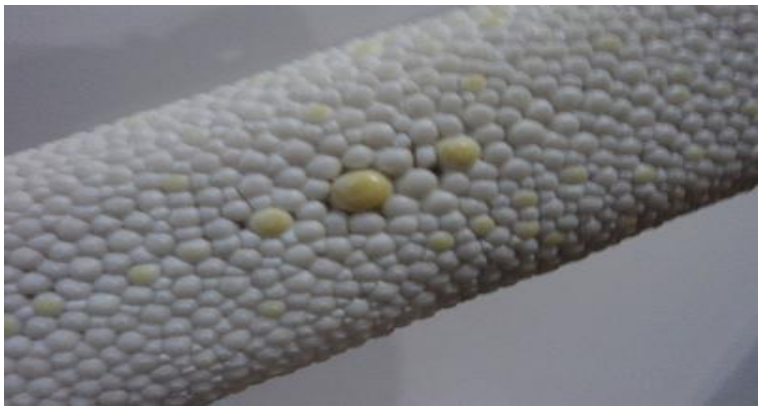


Figure 2 Skate skin were used on grip of swords and knives



Skates have been regarded as a predator on desirable market species such as lobster on the Eastern seaboard or Dungeness crab on the West Coast. While not directly stated, by implication the skate family along with the dogfish were thought of as nuisance with no apparent little appeal as a food item save for small local markets. They have been discarded or harvested at a minimal level along with many other species or until their livers became valued along with those of other shark family members for the extraction of vitamin A in the 40's.

Regardless, skate were landed in sufficient quantities to be recognized and reported along with a limited number of other non-salmonid fish from the 1904 in federal statistics and 1921 in Washington state annual reports. Washington Department of Fisheries did not report landings of any kind taken from waters outside of the state's territorial waters prior to 1935. Thus, any landing data prior to this should be considered minimum values. It is difficult to completely account for all landings because skate (*Rajidae*) were landed for human consumption, reduction

fertilizer, meal, liver, and animal food markets. Each of these markets included undefined species of skate in their composition. As a result a complete breakout of skate by species landed in Washington is difficult to find in the available literature. It is unfortunate that most descriptions associated with the market term "Skate: in the literature to skate are limited to one or two sentences.

References to skate, as an individual species, or a fishery, or in fisheries management studies, are rarely found. Photos taken in the early 1900's show skates being processed onboard (Figure 3) for unknown markets.

Figure 3 Skates being processed onboard fishing vessel cira 1900 (U.W. digital Collection)

While the market term "Skate" has always been a composite of multiple skate species but rarely coded as such. Often there was no specific species code breakout in actual catch compositions or biological samples. The most common code for WDF was 91. Codes which identified skate depended on the type of sample, or landing condition. Literature for the Washington fishery indicates that the market category "Skate" in Washington was almost entirely a composite of two species, *Raja binoculata* and *Raja rhina* (Smith 1936) (Chapman 1942) (Cleaver 1944). I found no data reported in my search through the literature which broke down "Skate" landings by species until reports after the year 2000. Despite this codes for trawl interview forms in 1968 had codes which identified both Big skate, and Longnose skate with individual codes of 91 and 92 respectively (1968 WDF). In subsequent sampling codes, these were lumped into Skate 91 with a use prefix such as 291 human consumption 391 reduction and 491 as animal food and 691 as discarded at sea for trawl log samples. In guides for port samplers conducting port samples, the BioSample species codes identified both species as "Skates" 85, Longnose skate 86, and Big Skate as 87. The outlier to the two species model is found in reports describing the Oregon and Washington reduction fishery, *Raja stelluata* , was mentioned in addition to these two species was also specifically identified as part of the reduction complex.

Early references to skate (*Rajidae)* indicate that like the other marginal market non-food categories they were a commonly identified as a discard species (Smith 1936) (Chapman 1942). Discard of the skate by-catch could be complete or selective based on size and market. The combination of comparatively early small annual landings and their clear identification as a discard species indicates that the market for *Rajidae* in any form was limited for a number of years until the vitamin A fishery expanded in the early forties to include species such as dogfish, ratfish, and rockfish. Fish were selected based on size and larger fish having liver and wings removed.

Often the condition in which the fish was landed is an indication of how the fish is utilized. Skate livers were clearly landed for the vitamin A market. Chapman (1942) recorded that "*At present they are being fished heavily, in common with the other elasmobranchs of the coast, for the vitamins in their livers. The carcasses are either thrown away at sea or made into fish meal. Little use is made of the excellent meat of the wings*" Cleaver reports skates from the otter trawl fishery were landed as "wings". Code books for WDF identify X 3 as the expansion factor for skate.

Determination of the landing condition of "Skate" in fish ticket data was further complicated until there was a more detailed breakout of the available landing data based on a unique code for liver, wings and whole. As described above, most references report that retained fish were dressed at sea and landed as wings thus needing some expansion factor for converting to round weight (Smith 1936). Federal statistics and WA fish ticket data clearly indicate that skate livers were sold along with "Skate" and utilized as a source for the Vitamin A fishery. While round (whole fish) were utilized in the animal food, reduction fisheries. While market specific landing data are ambiguous until the 1960's, the overall number of pounds landed likely landed as wings are readily available. The means to determine what portion of annual landings were destined for human consumption is not available until the 1960's when specific fish ticket codes were given to each of these possible dispositions.

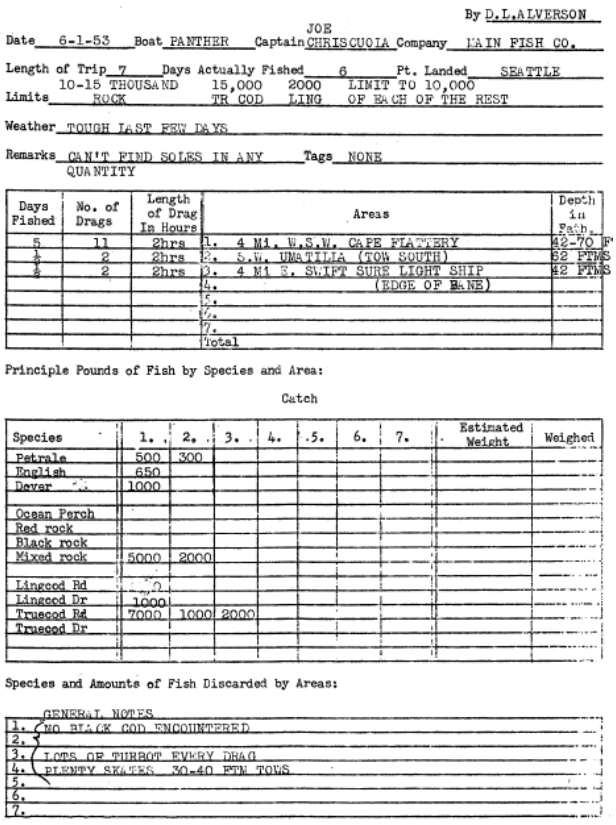
Possible Estimates of Species By Depth?

Skates along with other elasmobranchs have a wide geographic and depth distribution and are commonly encountered in the hook and line, net and trawl fisheries. Alverson's report "A Study of Demersal Fishes and Fisheries of the Northeastern Pacific Ocean" (Alverson 1964), reported that Skates (*Raja)* have a wide bathymetric range and greatest geographic distribution of the elasmobranchs. The trawl catch of skates was higher in the Strait of Juan de Fuca at depths greater than 49 fathoms and was found in all depth zones surveyed in the coastal waters of Oregon-Washington making this family vulnerable to a wide variety of fisheries. West coast distribution and life history for both species *R. binoculata* and *R. rhina* can be found in the 2010 Canadian technical report 2908 (McFarlane 2010) The early trawl fishery prior to 1935 occurred on a thin strip along the fifty fathom line (Smith 1936) and by 1942 this had expanded to a

hundred and twenty fathoms (Cleaver 1944). In 1952 the Pacific Ocean Perch fishery expanded the depth fished to 160 fathoms and 1953 the deep water Petrale fishery in the "Esteban Deep" expanded to fishing to 220 fathoms (WDF 1954).

Haul data from the Pacific Ocean Perch cruises from 1968-1972 made 92 hauls from 79-300 fathoms off the Quileute River. Only 5 tows caught skate and there were less than 50 pounds in each. Those hauls were made in 142-205 fathoms. Sixty three hauls on Cape Flattery spit from 80-258 fathoms. Only 1 hauls caught skate. The total was less than 50 pounds and was made in 118-122 fathoms (Jim Beam WDFW pers. com.). A review of the discard data from coastal trawl logs make few references to skates in depths greater than 160 fathoms. Shallow tows 30 fathoms to 120 fathoms note occurrences more frequently. Digitizing this discard, and observation data would provide a much more reliable estimate of occurrence by depth and amount of discard.

Figure 4 Log data from Washington Trawl Vessels 1953 - 1971



By D.L.ALVERSON

Date 6-1-53 Boat PANTHER Captain JOE CHRISCUOLA Company MAIN FISH CO.

Length of Trip 7 Days Actually Fished 6 Pt. Landed SEATTLE

Limits 10-15 THOUSAND ROCK 15,000 TR COD 2000 LING LIMIT TO 10,000 OF EACH OF THE REST

Weather TOUGH LAST FEW DAYS

Remarks CAN'T FIND SOLES IN ANY QUANTITY Tags NONE

Days Fished	No. of Drags	Length of Drag In Hours	Areas	Depth in Fath.
5	11	2hrs	1. 4 Mi. W.S.W. CAPE FLATTERY	42-70 F
½	2	2hrs	2. S.W. UMATILLA (TOW SOUTH)	62 FTMS
½	2	2hrs	3. 4 Mi S. SWIFT SURE LIGHT SHIP (EDGE OF BANK)	42 FTMS
			4.	
			5.	
			6.	
			7.	
			Total	

Principle Pounds of Fish by Species and Area:

Catch

Species	1.	2.	3.	4.	5.	6.	7.	Estimated Weight	Weighed
Petrale	500	300							
English	650								
Dover	1000								
Ocean Perch									
Red rock									
Black rock									
Mixed rock	5000	2000							
Lingcod Rd									
Lingcod Dr	1000								
Trueood Rd	7000	1000	2000						
Trueood Dr									

Species and Amounts of Fish Discarded by Areas:

GENERAL NOTES

1. NO BLACK COD ENCOUNTERED
2.
3. LOTS OF TURBOT EVERY DRAG
4. PLENTY SKATES 30-40 FTM TOWS
5.
6.
7.

Since landing data is the primary source of skate data, the associated ancillary data such as the landing location, gear type, and, finally the catch area in the 1940's become clues to the skate fishery. A review of gear types associated with skate catches in and early federal data and later in state statistics, suggest that it is likely that early landings (pre-1940's) were a salmon by-catch or

possibly the long line halibut/cod fisheries. The implication of these gear types is that skate were not specifically targeted and the amounts landed suggest that had they had a limited market for their landing. The salmon fishery by-catch diminished after the introduction of the otter trawl. Otter trawl became the primary means of harvest. The amount of skate reflected in early landing statistics prior to 1935 is probably a small portion of the total caught and landed. In terms of estimating number of skate caught by the commercial fishery, the number landed is minor to that of those discarded by all of Washington's various trawl and line fisheries.

Skate landing data reported in the two usual sources, 1) Officially published annual statistical reports by Washington Department of Fisheries and 2) Annual federal reports of national fishery statistics https://www.st.nmfs.noaa.gov/commercial-fisheries/commercial-landings/annual-landings-with-group-subtotals/index.

Federal landing statistics with skate landing information are intermittently available between 1904 and 1920, and consistently reported by 1922. For some unknown reason there is a gap in skate landing data for the years 1934 and 1935 in either federal or state reports (Table 3). There is no indication in the text for why they were not reported. Consistent reporting of skate landings resumes in both state and federal sources in 1936. Federal data provided by NMFS for Washington for 1950 – Present at:

https://www.st.nmfs.noaa.gov/commercial-fisheries/commercial-landings/annual-landings-with-group-subtotals/index

Landing values between state and federal sources rarely match after 1944 (Table 3). This may be a function of reporting period, where landing statistics were aggregated as fiscal year data (April – March) or calendar year values (January – December. It may also is probably a product of reporting the raw weights (un-converted or as landed) as opposed to reporting converted weights. When state fishery officials did convert skate wings to round weights in WA after 1935, a conversion factor of 3X (Jim Beam WDWFW pers. com.) was applied to the landing or NOAA 1993 indicates that liver represents and average of 23% of the total round weight. As to which is correct, I have no opinion and it will take further research to sort this out. Analysis of the state's statistical bulletins and reports suggest that this occurred by 1940.

In my opinion a difference in treatment of the state's fish ticket data are process must be the reason for these differences since both state and federal statistics use the state agency fish ticket data as a basis landing statistics.

Washington's director of fisheries published a series of annual reports to the governor and public from 1894 to the present. The skate landing statistics are found in these annual reports and bulletins. The reporting of WA catch data underwent a dramatic shift in 1935 due to a change in

shift in what type of information the fish ticket was to provide. The initial purpose of a fish ticket was taxation and after 1935 it was used as way to provide information to associate reported weights to a catch location. The primary drawback of state and federal reports is that for our purposes it reports landings by district of landing, Puget Sound, Coastal and Columbia River with pooled species information, no catch location and limited guidance how they were used in the markets.

Unfortunately data initial statistics were only reported only as in or out of the state's territorial waters but was eventually changed to names of grounds fished. In 1955 landing data was moved from compiled hand written ledgers to the school of fisheries IBM mainframe. This allowed numerous tables in various formats to be generated for use. This allowed for enhanced retrieval by managers enhanced reports and presentations.

A comprehensive view of landings in Washington can be found in Table 1. Landings of skate reached record highs in the early 40's again in the 50'. Statewide landings began to rebound in the 70's and continue to trend upward through 2017. Washington Department of Fish and Wildlife landing data are reported as fiscal year from 1922 through 1934.

Table 1 Washington State Landings of Skate 1904 - 2017

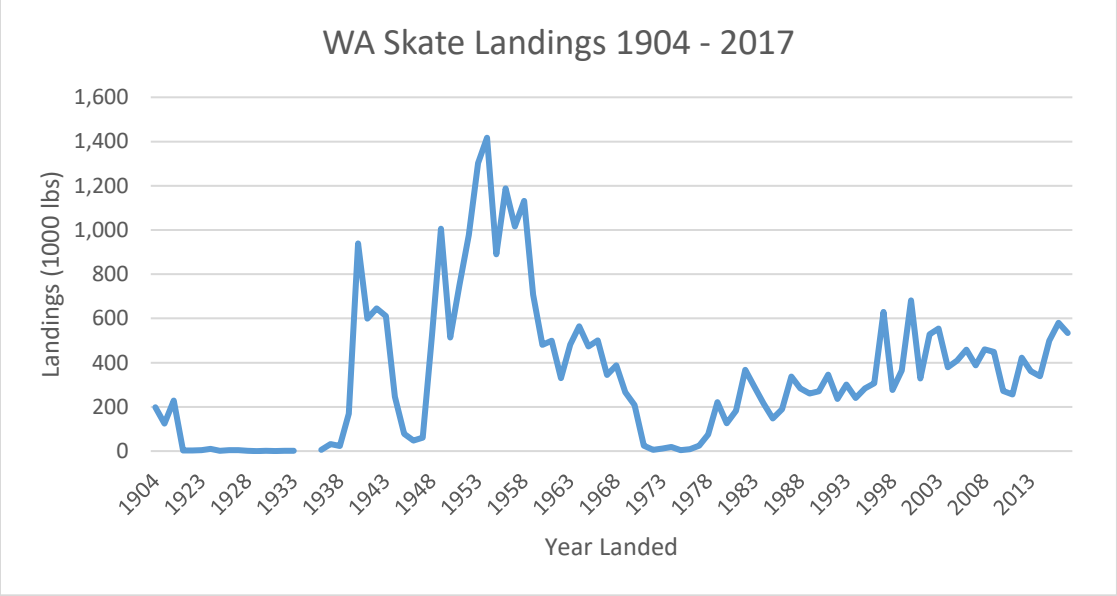


Table 1 is combination of Federal Fishery from U. S. Fish Commission 1904 – 1925, 1927-1931 WDF 1926, 1936 – 1941, and NMFS 1950 – 2017 data

Landing data is split into a pre-1935 and a post-1935. The authoritative source for post-1935 is the retrospective summary statewide landing tables by market category was published (Table 1) in each year's statistical report. These cumulative annual tables give the most complete time series of **total** Washington landings of the various species of commercial fish in Washington State (post 1935). The advantage of these retrospective data tables are; 1) They are a published

source which can be cited, 2) Annual amounts are finalized unlike the annual tables. However, WDF did not ever note in the statistical tables when the reported values went from “as landed” condition to an expanded fish ticket weight. The current LIFT catch reporting system starts in 1972. Note that the disposition of the landings identified as “Skate” were not explained in any WDF tables.

Table 2 Washington Department of Fisheries Comparative Annual Landings - Table of Other Food fish 1935-1969

Comparative Annual Landings of Other Food Fish All Districts Combined—In Number of Pounds—Continued

YEAR	Skate	Smelt, Eulachon	Smelt, Silver	① Steelhead	Sturgeon	Turbot	White Sea Bass	Total
1935.....	.....	2,199,185	453,738	418,468	18,543	.....	.....	25,696,558
1936.....	5,925	2,863,379	618,221	394,786	70,288	.....	.....	40,951,068
1937.....	31,923	2,224,732	423,850	469,172	105,468	.....	.....	60,351,361
1938.....	23,745	541,157	442,978	345,040	42,569	.....	.....	80,857,460
1939.....	169,540	2,560,708	563,039	319,536	41,084	.....	.....	63,523,357
1940.....	939,761	2,695,447	538,847	497,519	22,388	.....	.....	31,849,516
1941.....	598,600	2,415,217	538,013	466,947	18,324	.....	.....	65,919,889
1942.....	645,233	1,655,965	199,833	391,599	33,622	.....	.....	24,384,370
1943.....	618,550	3,374,075	220,045	327,952	52,114	.....	.....	50,806,438
1944.....	192,849	1,945,124	469,548	379,706	90,878	202,676	.....	33,774,011
1945.....	72,739	3,891,463	461,975	366,962	105,882	240,224	.....	33,174,709
1946.....	43,370	2,725,439	465,762	359,780	141,352	10,470	.....	36,575,577
1947.....	86,909	1,320,913	671,934	283,370	144,320	2,600	.....	20,235,592
1948.....	75,545	3,041,640	554,872	92,100	203,289	29,600	.....	22,767,319
1949.....	266,579	2,444,577	651,839	53,102	153,451	100	.....	21,873,000
1950.....	380,839	992,042	625,632	84,840	218,422	550	.....	17,627,886
1951.....	416,993	651,268	597,185	195,314	178,298	3,065	.....	16,451,198
1952.....	537,646	811,674	668,803	219,484	183,444	637	.....	19,753,987
1953.....	776,386	1,184,439	372,345	373,666	231,322	378,292	.....	22,215,308
1954.....	843,431	1,478,680	323,771	419,236	211,449	974,618	.....	25,891,944
1955.....	541,864	1,758,432	381,161	406,294	178,490	829,649	.....	24,058,603
1956.....	449,004	1,004,870	403,269	201,722	239,535	3,094,918	.....	27,170,780
1957.....	297,130	1,199,893	355,336	205,271	244,893	1,708,340	229	27,492,959
1958.....	398,398	2,387,372	438,387	227,095	216,968	1,922,870	4,972	39,687,220
1959.....	420,025	1,293,226	536,041	167,932	275,347	1,110,958	2,808	39,662,886
1960.....	273,267	1,042,856	344,958	190,096	248,992	1,898,707	473	32,484,962
1961.....	229,572	872,115	257,702	180,580	330,326	2,887,122	.....	29,469,699
1962.....	151,675	987,967	350,611	163,376	283,682	1,282,681	.....	31,973,548
1963.....	129,296	903,991	226,100	175,914	211,428	572,918	.....	30,785,232
1964.....	147,292	515,357	375,397	61,204	203,126	1,082,465	.....	25,631,922
1965.....	65,563	461,484	318,980	66,488	177,665	492,361	.....	30,870,202
1966.....	26,398	498,540	348,610	45,047	232,839	354,706	.....	32,491,578
1967.....	25,887	772,846	263,842	23,418	255,716	820,804	.....	53,526,472
1968.....	40,913	832,492	248,241	41,149	247,505	130,966	.....	37,074,046
1969.....	27,256	1,042,441	183,404	115,615	328,158	166,370	.....	37,000,514

①Columbia River landings only.

WA state landing data prior to 1946 were reported on a fiscal year cycle (April – March). Data reported for 1946 (WDF 1946) and thereafter was reported on a calendar year cycle (January – December). Summary tables were published in the 1946 report for combined, for each individual landing district. The post–1945 tables reported calendar year values and the 1946 report included a warning not to compare totals from the previous year’s annual statistical reports. This leads to the recommendation of using the retrospective landing table (Table 1) as a good starting point for total statewide non-reduction, or animal food markets, as is appears to be consistent in the way the data is reported. It is a source for all gear, all catch area annual estimates of WA catch.

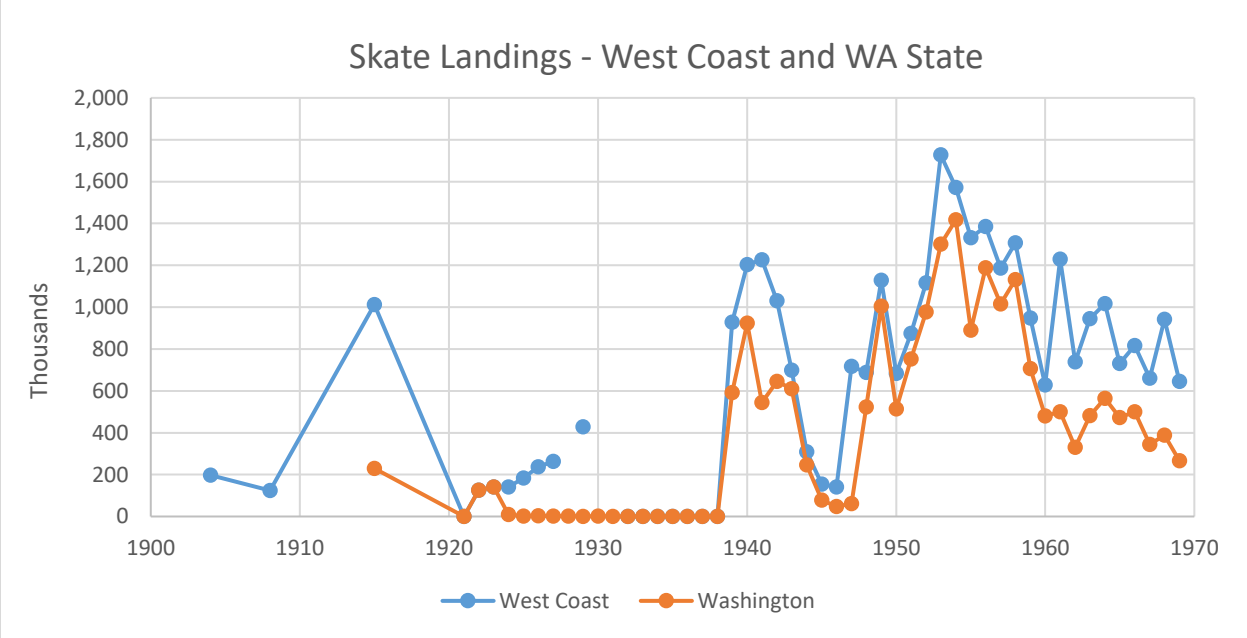
Pre-1935 data has no summarized table. For both state and federal statistics each year’s report must be reviewed. A comparison of coast wide landings to Washington state landings show that for most years show that Washington landed the majority of skates on the West Coast after 1939. (Table 2). Low landings for the 1904 to 1938 are likely an artifact of the method for gathering state statistics and accuracy of the reporting by Washington fish dealers to the department.

Table 2 Proportion of Washington Landings to Pacific Coast landings of Skate (Rajidae) by all gear types as Reported in United States Fisheries and Fishery Industries 1904 - 1969

Year	West Coast	WA Stats	% WA	Year	West Coast	WA Stats	% WA	Year	West Coast	WA Stats	% WA
1904	198,000	ND	ND	1936	ND	ND	ND	1954	1,572,000	1,417,000	90.1%
1908	124,000	ND	ND	1937	ND	ND	ND	1955	1,332,000	890,000	66.8%
1915	1,012,000	229,000	22.6%	1938	ND	ND	ND	1956	1,385,000	1,188,000	85.8%
1921	ND	ND	ND	1939	928,200	591,400	63.7%	1957	1,186,000	1,016,000	85.7%
1922	125,000	4,000	3.3%	1940	1,204,000	923,200	76.7%	1958	1,308,000	1,131,000	86.5%
1923	141,000	7,000	4.9%	1941	1,227,100	544,900	44.4%	1959	948,000	707,000	74.6%
1924	141,000	10,179	7.2%	1942	1,030,400	645,200	62.6%	1960	628,000	481,000	76.6%
1925	184,000	1,287	0.7%	1943	698,900	610,300	87.3%	1961	1,230,000	500,000	40.7%
1926	237,000	4,105	1.7%	1944	309,800	246,200	79.5%	1962	739,000	330,000	44.7%
1927	263,896	1,156	0.4%	1945	154,800	78,600	50.8%	1963	945,000	482,000	51.0%
1928		1,946		1946	140,700	47,700	33.9%	1964	1,017,000	564,000	55.5%
1929	428,351	365	0.1%	1947	717,000	61,300	8.5%	1965	731,000	473,000	64.7%
1930		1,170		1948	688,700	523,600	76.0%	1966	817,000	500,400	61.2%
1931		344		1949	1,128,400	1,005,000	89.1%	1967	660,000	344,000	52.1%
1932	ND	ND	ND	1950	684,400	513,300	75.0%	1968	942,000	387,900	41.2%
1933	ND	ND	ND	1951	874,900	752,000	86.0%	1969	646,000	266,100	41.2%
1934	ND	ND	ND	1952	1,116,300	977,100	87.5%				
1935	ND	ND	ND	1953	1,727,100	1,301,900	75.4%				

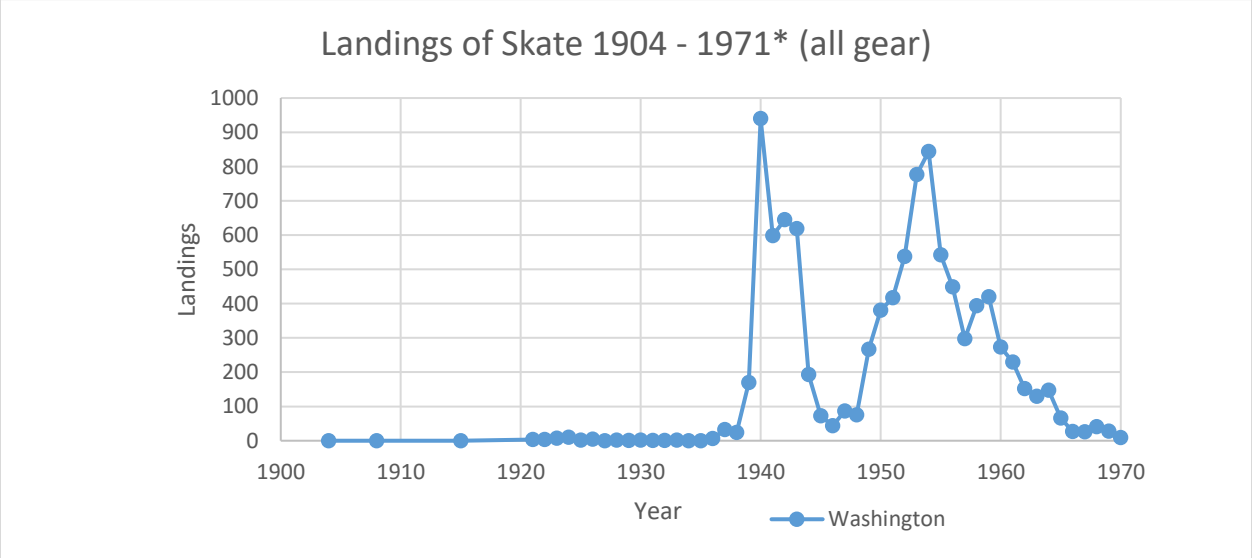
Figures 1 and 2 describe the proportion of “Skate” in Washington to that of the entire United States West Coast. Landings prior to 1940 are at very low levels. Landings climb in the 1940’s and subsequently decline in the post war era along with many other commercial species markets. The increase in demand for reduction and animal food provide an increase in the 50’s.

*Figure 5 Trends of West Coast Landings and Washington Landings of Skate (all gear types) 1904- 1969**



**Data are taken from Fishery Statistics of the United States.*

Figure 6 Washington Skate Landings 1904 -1970



**Data are taken from Washington Department of Fishery Annual Statistical Reports*

The overall trend of landings in Washington State follow the trend of the entire West Coast. That is fact largely due to Washington's proportional contribution to the coast wide landings.

A second ambiguous source of skate landings in Washington are the portion of the "scrapfish" market category. Skates are specifically reported or mentioned in Washington's summarized landings table (Table 1) and in the "scrapfish" category (Table 2). The documenting of the scrapfish category begins in 1944 (why 44?). By 1966 WDF added codes to the fish ticket species that further described the intended disposition to human consumption, scrap/meal, animal food and liver.

Table 3 Washington Department of Fisheries Comparitive Annual "scrapfish" 1935 - 1969

Comparative Annual Landings of Other Food Fish All Districts Combined—In Number of Pounds—Continued

YEAR	Herring	Miscellaneous	Pilchard	Ratfish	① Scrapfish	Shad	Shark② All Species
1935	137,856	.....	12,373	.....	.....	65,806	.....
1936	908,637	.....	13,114,464	.....	.....	57,436	.....
1937	876,195	125	34,429,082	.....	.....	37,606	.....
1938	1,015,756	619	52,976,013	.....	.....	52,734	42,500
1939	283,417	977	35,527,893	134,000	.....	87,018	1,124,062
1940	923,400	.....	1,647,184	638,830	.....	111,103	3,259,909
1941	294,578	.....	34,199,968	2,444,761	.....	102,787	4,383,338
1942	72,570	.....	1,167,888	1,452,498	.....	194,579	1,734,189
1943	787,510	.....	21,082,125	1,156,575	.....	86,808	3,967,297
1944	605,386	.....	83,628	2,436,798	464,808	228,007	2,919,637
1945	538,211	.....	4,725,840	1,694,763	730,794	423,266	1,240,876
1946	454,540	.....	12,290,035	1,780,094	602,176	787,651	688,769
1947	1,194,826	.....	2,850,321	1,362,876	748,382	709,237	638,090
1948	484,990	1,549	108,372	939,235	894,099	43,250	466,061
1949	839,735	.....	56,435	930,926	620,602	71,892	290,669
1950	388,160	34	.....	384,695	322,705	322,557	117,600
1951	545,560	62	1,700	348,486	908,336	218,214	382,508
1952	717,592	.....	.....	981,094	1,323,287	224,586	521,704
1953	565,778	350	.....	893,055	1,543,860	165,908	836,185
1954	265,452	.....	.....	703,034	1,593,525	152,869	811,045
1955	460,242	.....	.....	825,262	1,339,744	158,055	733,475
1956	532,293	516	.....	856,203	2,954,110	141,731	416,220
1957	1,097,143	444	.....	841,054	4,102,548	68,067	448,464
1958	8,303,308	224	.....	1,146,898	3,547,197	95,642	1,363,161
1959	5,536,566	105	.....	1,689,595	2,900,989	56,390	1,425,419
1960	4,103,417	2,035	.....	893,970	1,463,551	56,382	866,395
1961	3,602,202	202	.....	1,050,377	1,243,699	167,302	580,700
1962	6,368,842	8,535	.....	1,003,870	2,176,619	346,662	567,660
1963	6,971,822	28,689	.....	720,400	2,187,178	192,687	567,336
1964	3,960,406	23,543	.....	1,270,700	1,889,768	34,087	1,700,414
1965③	8,346,585	2,641,860	.....	1,317,450	2,701,165	83,997	1,876,650
1966	4,514,937	130,033	.....	830,250	2,630,702	353,319	1,408,460
1967	6,447,435	57,700	.....	784,456	1,839,736	256,731	978,593
1968	6,447,454	112,842	.....	544,023	1,791,205	45,621	368,622
1969	8,281,613	293,521	.....	832,461	1,958,259	56,885	324,701

①Mixed dogfish, ratfish, skate and shark, and other species landed as scrapfish. ②See Separate table for individual species of shark. ③1965 Miscellaneous column includes 2,549,592 lbs. yellowfin, skipjack and bluefin tuna.

The Geography of Washington Skate Landings

Prior to the expansion of the trawl fishery between 1939 and 1942, the majority of skate landings likely came from Puget Sound and the Strait of Juan de Fuca. Coastal landings (non-territorial waters) were not recorded by the department prior to 1935 combined with the small market demand would support this. Fish ticket information to identify the area of catch was implemented in 1935. Further complicating assignment of catch area is the reporting of statistics by district of landing.

The first breakout of state wide landing statistics are identifying fish caught in Puget Sound and those taken from Coastal Waters termed "Outside". Puget Sound waters extend from Budd Inlet to the south and the Canadian border at Blaine, and include the Strait of Juan de Fuca. Coastal waters would be include coastal waters of Oregon, Washington, and Canadian waters to the Queen

Charlotte Islands. There are only one source which provides some data on this geographic split of geographic origin of catch. The first is Washington's fish ticket reporting system.

The fish ticket system was initially designed to report amount for revenue purposes. The area of catch was not included in the metadata for a landing. In 1935 the need for data associated with fisheries management and associate interview data with fish ticket data for statistical management of fisheries resources was initiated (Alverson 1957). Unfortunately the overall way the fish ticket data was reported was by district of landing. The change in 1935 identified at least one area that was where the majority of the catch was taken from

A subset of this fish ticket data was created that focused on landings of ground fish from Puget Sound. So the best source of data for breaking out landings of skate from Puget Sound Waters is the "Yellow Book" data series (Table 4). If you are convinced that it does indeed represent landings from Puget Sound waters this is the first step to identifying the coastal portion of the catch. In my opinion this dataset is the compiled fish ticket data with a Puget Sound waters as the catch area.

*Table 4 Landings of Skate from **Puget Sound** Waters 1921-1969 (WDF Fish Ticket statistics)*

Year	WDF An. Stats		Year	WDF An. Stats		Year	WDF An. Stats
*1921	2,844		1938	7,900		1955	539,024
*1922	3,242		1939	573,208		1956	443,404
*1923	7,317		1940	555,233		1957	292,678
*1924	10,269		1941	590,864		1958	398,053
*1925	1,286		1942	605,679		1959	421,295
*1926	4,105		1943	566,867		1960	272,079
*1927	1,156		1944	156,970		1961	221,325
*1928	1,891		1945	66,631		1962	142,255
*1929	365		1946	32,778		1963	125,513
*1930	1,170		1947	75,047		1964	142,381
*1931	361		1948	69,369		1965	59,280
*1932	1,013		1949	253,849		1966	26,398
*1933	1,500		1950	377,049		1967	14,331
1934	0		1951	409,154		1968	25,060
1935	0		1952	525,204		1969	15,255
1936	1,975		1953	776,370		1970	8,609
1937	10,618		1954	841,231		1971	0

- Fiscal Year

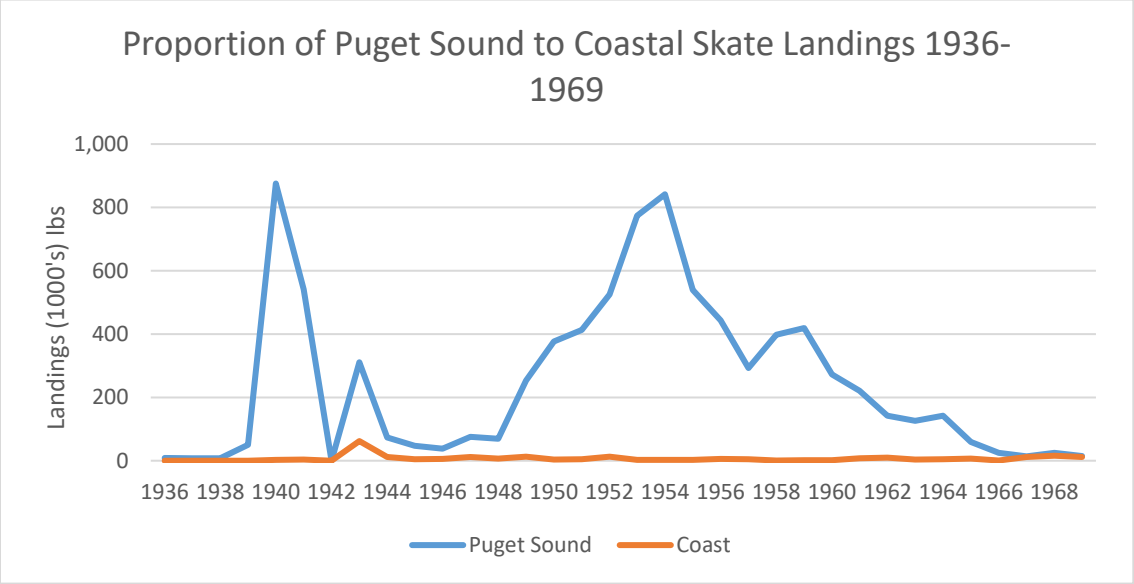
In this data series, note that "Skate" are identified as a component species of the reduction fishery but were not found in the animal food species category.

If we look at the fish ticket data alone, the estimated proportion of coastal catch between 1936 and 1949 is small in comparison with the Puget Sound catch (Table 5 and Figure 3).

Table 5 Breakout of estimated Annual Catch of Skates from Puget Sound and Coastal waters 1936-1971

Unfortunately with fish ticket data we have a limited to a time frame to answer this. This is because with the Washington fish ticket data (BoundVolume) we have time series that begins in 1936 (1935 and 1942 incomplete (Table 4), the estimated proportion of the coastal catch is much smaller until 1967. *Link to Table 5 Click on link to see table*

Figure 7 Estimated Proportion of Skate Landings from Puget Sound to Coastal Waters 1936-1969



It is important to note that Washington did not record landings of fish taken outside of territorial waters until 1935 and the state switched to reporting landings based on a calendar year in 1947. All "outside" trawl fishery occurred outside of the state's territorial waters. After 1935 all landing monthly data reported in Washington's annual reports included fish taken from both states territorial and extra-territorial waters and outside landings were reported in the bulletin separately for a five year period. The 1936 bulletin specifically indicates that "no record of skate wings available for 1935". Skates caught in out outside waters were reported beginning in fiscal year 1942 through 1946. Summary tables by calendar year were published in the 1947 bulletin.

Table 5 Landings of Skate from Washington State Territorial and Outside Territorial Waters (lbs) 1942 - 1946

Fiscal Year	Total Landings	Outside	% Coastal Waters
1942	674,989	16,870	2.50%
1943	236,086	28,386	12.02%
1944	82,491	9,222	11.18%
1945	74,647	5,663	7.59%
1946	43,313	5,471	12.63%

To me this suggests that during this time frame, the price (.01 cents/lb) and market for skate was reduction and not human consumption. A later discussion of gear shows the shift from skate as a by-catch of the salmon fishery gear types to being an element of the otter trawl fishery and the otter trawl being able to catch more than the limited market for these species needed .

In order to provide another independent estimate with an area of catch, an effort was undertaken by the Washington Department of fisheries to convert annual statistics generated by the data division each year beginning in 1935. These bound volumes were entered into a two MS Access databases, WAMFLandings and BoundVolumes Table 5, though derived from the same source it is useful to see a comparison of total landings published in the annual state fishery statistics and those calculated from the Bound Volume statistics.

With the exception of 1940 to 1944, and the 50's, skates were landed in most months of the year and were primarily landed in the October to February period (Table 5). Unfortunately the states reporting format changed in 1950 and landings by month for skate were no longer reported. Note that during the landings during the years of WWII, the landings were also reported in the March through November time frame. The expanded time frame for landing was like other species during this period was due to the increased demand for protein and returns to a winter fishery November to February.

Table 6 Distribution of Skate Catch by Month 1937 – 1950 (WA Annual Landing statistics)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
FY1937	3,152	2,956	805	414	110	0	11	30	28	116	285	2,434	10,341
FY1938	1,587	1,700	400	915	0	31	212	67	45	244	890	1,824	7,915
FY1939	2,489	387	803	0	0	41	0	69	95	50	12,931	18,313	35,178
1940	47,673	62,793	31,513	46,705	71,625	27,755	36,737	39,955	32,020	27,828	9,256	146,116	579,976
1941	262,640	77,967	57,533	59,120	21,949	10,306	9,285	14,788	23,306	478	10,988	50,240	598,600
1942	113,628	123,079	107,525	115,400	37,835	5,720	7,320	28,870	16,455	23,218	23,255	37,728	640,033
1943	78,657	160,763	134,768	91,472	52,269	11,020	14,370	5,270	5,162	33,402	26,659	26,462	640,274

1944	53,994	36,085	31,864	23,876	5,962	6,685	30,355	4,640	3,556	1,149	7,220		205,386
1945	2620	10,231	8,480	28,464	8,274	600	0	0	22	0	2,445	10,385	71,521
1946	7,659	7,356	9,442	1,610	880	1,095	285	18	303	2,930	5,030	6,705	43,313
1947	5,857	17,937	12,310	12,572	1,725	135	258	3,600	298	870	19,454	11,893	86,909
1948	7,237	2,611	21,455	18,760	5,270	353	450	595	605	1,093	8,918	8,298	75,645
1949	10,263	30,505	141,042	42,155	25,001	4,200	0	0	243	790	3,730	6,850	264,779
1950	1,075	115,320	121,035	37,465	43,000	14,860	3,105	285	600	4,195	5,174	34,025	380,139

Table 7 Landing Statistics for Skate (Rajidae) in Washington as Reported by WDF Annual State Statistics and WA Fish ticket (Bound Volume) Annual 1936-1969 By Calendar Year

Year	WDF An. Stats	Fish Ticket Stats		Year	WDF An. Stats	Fish Ticket Stats
1936	5,925	8,888		1954	843,431	843,431
1937	31,923	7,415		1955	541,864	541,864
1938	23,745	7,907		1956	449,004	449,004
1939	169,540	573,258		1957	297,130	297,130
1940	939,761	924,999		1958	398,398	398,398
1941	598,600	544,401		1959	420,025	420,025
1942	645,233	ND		1960	273,267	273,267
1943	618,550	373,066		1961	229,572	229,572
1944	192,849	85,336		1962	151,675	151,675
1945	72,739	51,408		1963	129,296	129,296
1946	43,370	43,370		1964	147,292	147,292
1947	86,909	86,909		1965	65,563	65,563
1948	75,645	75,837		1966	26,398	26,398
1949	266,579	266,579		1967	25,887	25,887
1950	380,839	380,899		1968	40,913	40,913
1951	416,993	416,993		1969	27,256	27,256
1952	537,646	537,646		1970	9,170	ND
1953	776,386	776,386		1971	24,010	ND

*No data is available in federal or state statistics for 1935

Historical Markets for Skate in Washington

It is important to understand the relationship between the market category "Skate" and how it figures in estimating total catches of skate in Washington by species. In state and federal statistics, the meaning of the market category "Skate" is never really defined or explained. The first insight

into species, markets and catches of skate is in the first report on the otter trawl fishery in Washington (Smith 1936).

Smith reports that the otter trawl fishery is it is principally two species *R. rhina* and *R. binoculata*. Skate are not even mentioned unlike ratfish and dogfish as a component of the extraterritorial otter trawl fishery (50-70 fathoms), but these two species predominate in the Puget Sound catches along with a trace of "spiny skate" identified only as *R. sp*. In the description of the Bellingham trawl fishery Smith states that "*The Long nosed and Big Skate are very abundant in Bellingham Bay but owing to the limited market for skate wings, only a few are marketed*" . They are remarked on again in the Georgia Straits otter trawl fishery *"The skate are also well represented. The pectoral fins of the large skate taken here are marketed by a few trawlers. These are the "skate wings" of commerce".* While he notes them as primarily discarded, Smith states that "*Skates withstand discard well and appear to be in good condition when thrown back into the water"*. In my opinion it is likely that these weights shown in Table 1 were wings, dressed at sea with the balance of the carcass discarded but note that this is never stated in the states reports. Internal memos of the department in 1942 report that "*Skate wings are being saved rather consistently on most boats at the present time"* but how they were used is not reported.

Additional landings are hidden in the other three market categories reduction/meal, animal food and liver. No descriptions of the consumption of skate by early settlers in Puget Sound or coastal was found. It is likely that skate found in the fresh market as shown in Figure 1, were an item of display to attract attention and not a commonly consumed market species.

Figure 8 Skate on displayed in Early British Columbia Fish Market

It will take further research to estimate how much skate made up annual reduction/meal or animal landings in addition to the undefined market category "Skate". The separation of a skate as food fish (human) from the other categories is next to impossible prior to the addition of fish ticket codes. In addition to reduction /meal and animal food we have clearly identified skate liver landings, we can only conjecture if on such a limited market that only the liver (much higher ex-

The best data that reports the landings by market for Skate landed in Washington is found in the annual trawl Washington Department Groundfish Data Report Series 1963-1974. This data series clearly apportioned annual landings between 1963 and 1979 by the number of pounds for "Food Fish (Human Consumption)", "Reduction (Meal/Oil)" and "Animal Food" markets for the skate caught by in coastal and Puget Sound waters (Table 2).

Table 7 Disposition of Skates landed by Otter trawl between 1963 and 1979 (Annual WDF Trawl Reports)

Year	Food fish	Fish Meal	Animal Food	Total_lbs	% Food fish	Pcent Fish Meal	% Animal Food
1963	10,146	119,150	0	129,296	7.85%	92.15%	0.00%
1964	16,102	131,190	0	147,292	10.93%	89.07%	0.00%
1965	15,801	49,762	0	65,563	24.10%	75.90%	0.00%
1966	10,298	16,100	0	26,398	39.01%	60.99%	0.00%
1967	8,414	5,600	11,873	25,887	32.50%	21.63%	45.86%
1968	9,005	18,600	13,306	40,911	22.01%	45.46%	32.52%
1969	8,763	7,915	10,461	27,139	32.29%	29.16%	38.55%
1970	7,071	1,960	0	9,031	78.30%	21.70%	0.00%
1971	24,006	0	0	24,006	100.00%	0.00%	0.00%
1972	6,272	0	0	6,272	100.00%	0.00%	0.00%
1973	121,234	0	0	121,234	100.00%	0.00%	0.00%
1974	18,363	0	0	18,363	100.00%	0.00%	0.00%
1975	3,862	0	0	3,862	100.00%	0.00%	0.00%
1976	7,900	0	0	7,900	100.00%	0.00%	0.00%
1977	22,650	0	0	22,650	100.00%	0.00%	0.00%
1978	73,814	0	0	73,814	100.00%	0.00%	0.00%
1979	213,021	0	0	213,021	100.00%	0.00%	0.00%

Note that data in Table 5 are landings by the otter trawl fishery, however by the 1960's otter trawl captured the majority of the skate landed in Washington State. Unfortunately we have no such breakouts prior to the 1960's.

Human Consumption (Food fish or "Skate on the Plate")

It has been documented that Coastal and Salish tribes made skate a part of their diet. (http://traditionalanimalfoods.org/fish/saltwater/page.aspx?id=6441).

Skates were utilized by first nations as a food item on the west coast of North America. Anecdotes by Swan describe cooking and eating skate on a canoe trip with tribal members. Swan describes returning from a canoe trip and sharing a large skate for meal with the Makah guides (Swan 1870)

Luhnein and Humpries report that northwest coast tribes included skate in their diet as well. (traditionalanimalfoods.org/fish/saltwater/page.aspx?id=6441)

> *The Coast Salish were reported to have eaten rays [6]. Although the species of ray was not specified, it may have included pelagic stingrays. Small rays were barbecued while the larger ones were baked; both were prepared whole after being gutted, but not deboned as they are a very flat fish. They were barbecued until flaky on large barbecue racks made from wood poles and sticks, and were baked in an imu pit after being wrapped in a layer of clean seaweed. Stones were added to the pit and a fire was started using cedar tinder. When the fire was burning well, alder was added and the resulting coals were laid on rocks to heat them. When the fire had completely turned to coals, the coals and some of the rocks were set aside and the wrapped fish was placed on the remaining rocks. The coals, hot rocks, and gravel were heaped on top and the ray was baked for around one hour* (Batdorf C. 1990)

McKechnie and Moss report that skates (unknown species) are found in tribal middens were reported on an average of 24.8% in 222 fine screened assemblages analyzed between Oregon to Alaska. (McKechnie, and M.L. Moss 2016)

Evidence suggests that early Washington non-native use of skates was primarily for meal or oil. In 1942 the author comments that there is little use of skates for human consumption, but are heavily fished for liver (Chapman 1942). While skate are mostly commonly categorized as "scrapfish" in the literature, it is likely that few of the pounds reported to 1960 are destined for human consumption. Text from a 1947 leaflet on Washington fishes, says

> "*Scrap discarded in the canning of salmon, tuna, and crab, and in the filleting of bottom fish is an additional source of oil and meal. Also utilized are whole herring, grayfish (with livers removed),* ***skates****, Rat fish, and other species not presently being marketed for food*"

A WDF pamphlet of undetermined publication date (40's or 50's) stated describing Washington's Food fishes stated:

> "*Skate wings are used to a small extent in the fresh fish market*"

This is the sum of our knowledge of the human consumption of skate in Washington.

Scrapfish – Reduction/meal and Oil

Skates are one of several species identified as a source of oils for paint in 1919 (Radcliffe 1920). Footnotes in Table 2 note that skate were a component of the market category "scrapfish". Scrapfish were ground into a meal that was supplementary to animal food as a protein source or reduced for oil. These were likely whole fish, primarily caught in Puget Sound and consisted of *R. binoculata, R. rhina and R. stellatua*. Bathyraja kincaidii. More importantly for our purposes little information is available on what portion skates made up of the scrapfish class in Washington. A breakdown of the scrapfish category the 1940 Pacific fishermen reported that of the 3,802,170 lbs of "scrapfish" landed in the Puget Sound District, only 5.9% were identified as skate with the primary species dogfish at 83%. A Puget Sound study broke out the skate component of scrapfish in Hood Canal (18%), South Puget Sound (10.7%, and South Sound (10%).

Figure 9 Composition of "Scrapfish" in 1940

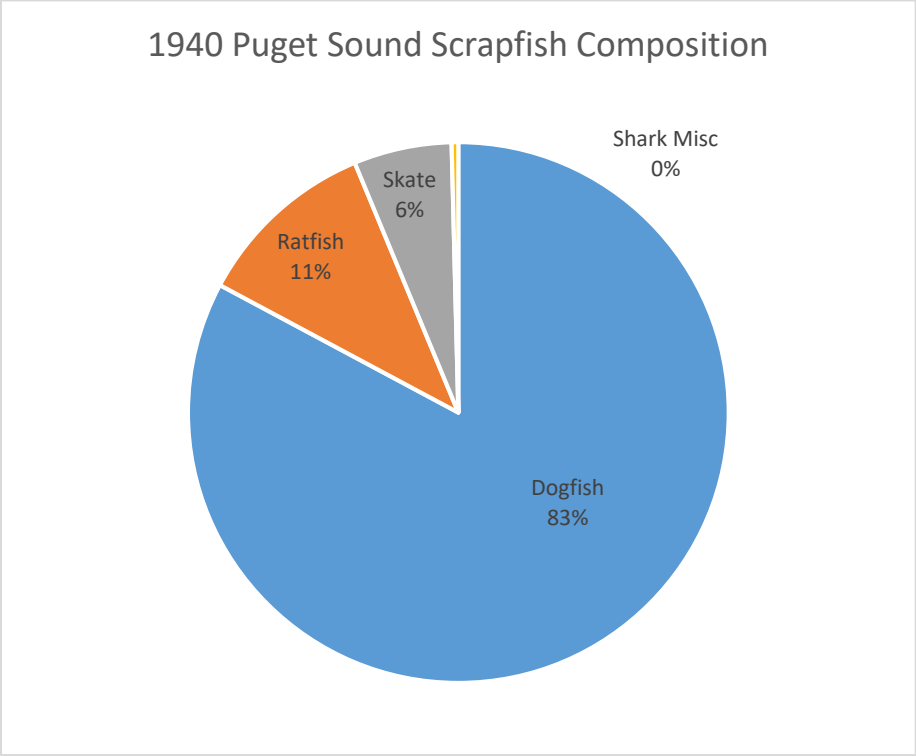
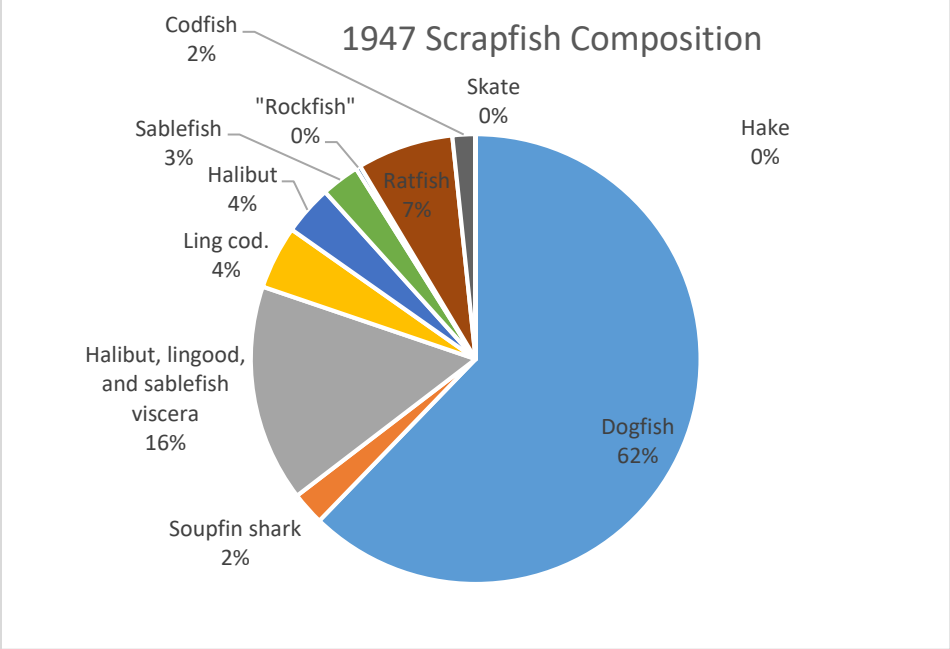


Figure 5 Proportion of Species in the Scrapfish Category in 1947



Reduction also meant that both frames and whole fish were utilized for their oil for paints and even today (Figures 5 & 6).

Figure 10 Pacific Fisherman advertisement 1919

An article from Pacific Fisherman (1940) reports that the number of scrapfish reduction plants in the Puget Sound was expected to reach a high level in 1940. All the research indicated that pilchards, and dogfish were the primary species in the reduction market. It was also susceptible to foreign imports and east coast shipments of menhaden. A review of the literature oil/meal fishery in Washington and elsewhere indicate while Skate was included in the species processed, it was likely a very minor player in this market and were supplied primarily from Puget Sound vessels operating in Puget Sound Waters.

"For the year ending August, 1940, total of scrapfish landed in the Puget Sound district were reported by the Washington State Fisheries Department as approximately 4,000,000 lbs. Included were the following species and amounts: dogfish, 3148,680 lbs.; ratfish 415,598 lbs; ***skate 222,747 lbs****., and shark, 15,145 lbs. Except for minor amounts of skate, all of these quantities were reduced for oil and meal"*

Data from annual reports to the PMFC ground fish report series breaks out the otter trawl skate catch by disposition. We see a transition of skates being landed as meal/reduction to almost exclusively human consumption in 1970 in Washington (Table 3). This is true of Canada 1996 (Benson et al. 2001) and California starting in the 1990's (www.floridamuseum.ufl.edu/discover-fish/species-profiles/raja-binoculata/)with the apparent success in marketing skate as "another white fish".

The market for oil from skates and ratfish was instable. Bonham states that in 1942 the market for livers had been shut down (Bonham 1942). Whole skates from an otter trawl fishery in Boundary Bay could only be landed in the round for five dollars a ton.

Animal Food

Washington has few references on the composition of the animal food market. As a result we look to Oregon and Canada for data. In general, the animal food market was primarily frames and round fish ground up for mink farms and closely tied to fresh market landings of filleted food fish. The proportion of Skate in British Columbia utilized for mink food was of note for only three years as shown by Table 5. A breakdown of species in the Canadian mink food industry shows that it was minor as well. To further confuse an accurate accounting for Puget Sound landings, as much as six percent of the South Puget Sound landings identified on the fish ticket were really skate (Table 6).

Table 6 B.C Study of Species Composition of Mink food.

Table II. Percentage composition of species contributing to otter-trawl landings of mink feed.

Species	1951	1952	1953	1954	1955	1956
Turbot (arrow-toothed sole)	71.0	71.3	53.8	56.4	65.5	57.5
Whiting (bigeye)	19.3	20.7	17.8	16.5	20.2	22.5
Hake	4.2	2.6	1.1	2.4	0.6	*
Skate	0.5	0.5	0.5	2.4	0.7	1.1
Starry flounder	*	0.5	0.3	0.5	0.5	4.8
Lemon sole	*	0.4	6.6	5.6	0.4	*
Misc. sole	*	0.1	6.2	3.9	1.6	1.9
Grey cod	*	0.1	4.0	3.6	2.0	1.7
Butter sole	*	*	7.9	1.9	5.3	7.7
Rockfish	*	*	1.7	6.2	2.5	2.6
Other species	5.0	3.8	0.1	0.6	0.7	0.2
Total:	100	100	100	100	100	100

* Negligible quantities landed

Table 6 Proportion of Species sole as English sole for South Sound Animal Food.

Table 4. Species compositions (percent by weight) of South Sound animal food trawl landings sold as "English sole".

SPECIES	Year Sampled: 1970 Years Applied: 1970-73	1974 1974-78	1982 1979-82	1984 1983-87	1988 1988
English sole	82.7	47.3	85.8	68.3	77.9
Dover sole		0.7	0.2	0.4	
Rock sole	2.2	4.1	1.0	0.5	0.7
Sand sole	2.7	2.5	0.9	1.3	3.0
Sanddabs		0.1	0.2	0.2	0.2
Starry flounder	3.2	2.3	0.3	0.5	0.4
Arrowtooth flounder		0.8			
Misc./unident. flatfish	1.0	2.5	0.5	4.9	1.5
Brown rockfish			1.3		
Quillback rockfish				0.4	
Misc./unident. rockfish			0.3		
Pacific tomcod	3.9	15.1	0.2	1.9	2.2
Walleye pollock		2.9	1.1	2.2	
Pacific whiting		0.4	0.3	0.4	
Pile perch	0.3		0.2	1.4	0.4
Sculpins	0.7	1.9		0.4	0.7
Skates	1.2		4.2	6.3	1.8
Spiny dogfish		0.3		0.7	0.4
Plainfin midshipman	1.4	8.8	3.1	6.5	1.1
Ratfish			1.5	0.2	
Misc. foodfish	0.7	10.3	0.2	2.2	9.7
TOTAL	100.0	100.0	100.0	100.0	100.0

Liver

The market for skate livers is a result of the suspension of cod fish liver oil imports due to the invasion Norway by Germany and dogfish liver oil from Japan during WWII (Fishery Market News 1942). The focus for sources of oil for the production of vitamin A were directed toward the West Coast and the shark fishery targeting dogfish *Squalus suckleyi* and subsequently Soupfin sharks *Galeorhinus zyopterus*. The market than became so strong that many other species of shark became targets for this market. Demand for livers became so strong that other sharks ratfish, skates and rays were utilized and were termed “junk” species. In Washington livers from Pacific Halibut, sole, rockfish, black cod, smelt and candlefish were used and can be found in the Washington fish ticket data.

Skates *uniden,* are represented in the suite of species that contributed to landings of liver in Washington for the Vitamin A fishery. The critical question is how do we interpret the reported landings of skate liver in relationship to the total round weight of annual “Skate” landings? This is not a straight forward a question as it appears at first glance. Given that “Skates” were clearly documented as being landed as wings and the rest (body and liver?) of the carcass discarded at

sea. No mention is made of the manner in which the livers were landed. Were the livers removed at the same time as the wings and placed in tin cans? This clearly the case for the dogfish. Given the limited market for wings, the value of skate liver leaves open the possibility that skate, like dogfish were livered at sea and some portion of the liver landing value may represent a value that would need conversion to a round weight. Bottom line is that we cannot know and remains as a potential non-recorded skate catch.

There are only 2 sources of statistics for skate liver landings. Unlike meal/reduction and mink food landings of annual amounts of skate liver are reported as a footnote in the federal statistics show in Table 10 and in the WA fish tickets 1940 - 1954. After 1954 Skate were either not landed or landings were so low that they were merged into the "Miscellaneous Liver category. State landing data were reported by district of landings which generally align to area of catch (Puget Sound District withstanding) Table11 . <-*Click on hyperlink*.

Table 7 Landings of Skate Livers in the Puget Sound District 1942-1952 as Reported in Fishery Statistics of the United States

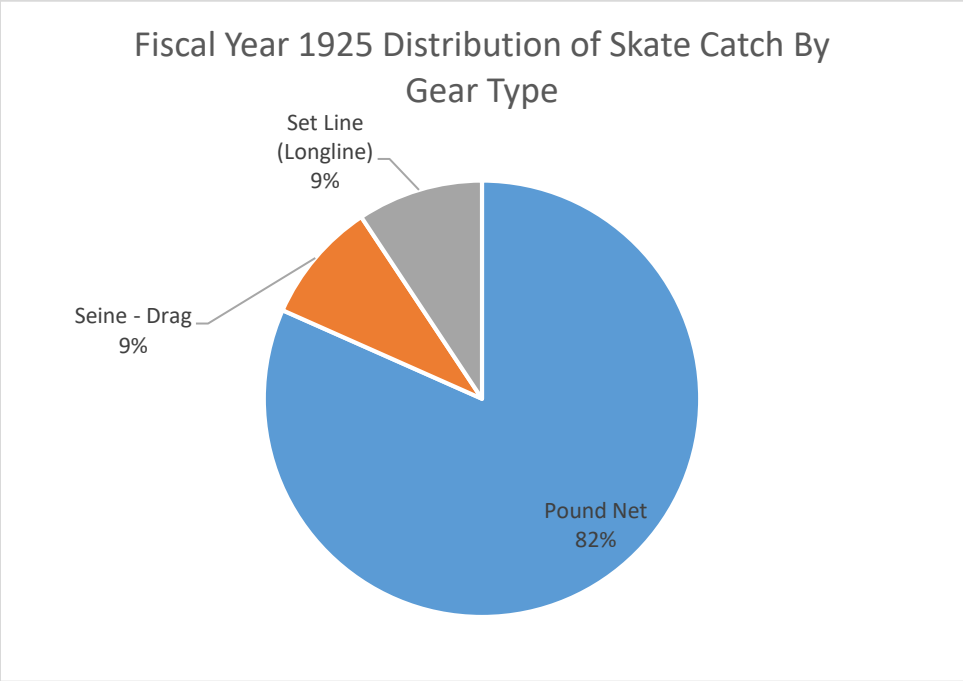
	1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952
Cod Liver			46,173	185,696	107,818	48,227	67,305	58,534			
Soupfin Liver	619,225	415,300	357,345	164,706	71,258	69,003	78,995	68,396	15,060		1,724
Dogfish Liver			4,740,482	2,653,275	2,519,023	1,798,183	1,476,306	1,207,434	210,798	207,722	242,552
Lingcod Liver	297,897	103,921	294,069	274,067	1,919,026		165,308	92,203	107,100	102,900	77,307
Halibut Liver	264,699	314,748	208,277	226,746	226,284	104,549	177,304	180,083	154,464	198,206	199,805
Hake Liver					11,938	1,024	4,523	1,988			
Skate Liver	25,808	24,412	7,322	2,997	1,905	24,524	17,918	29,609		18,000	
Rockfish Liver	21,680	69,105	25,398	24,400	2,000	9,504	9,187	9,347	10,800	12,640	
Ratfish Liver	174,288	173,490	364,506	254,214	267,014		51,286	78,581			
Sablefish Liver	280,951	139,410	84,525	52,747	92,944	80,479	74,546	5,460	76,673		79,520
Other Shark							101,032			164,161	

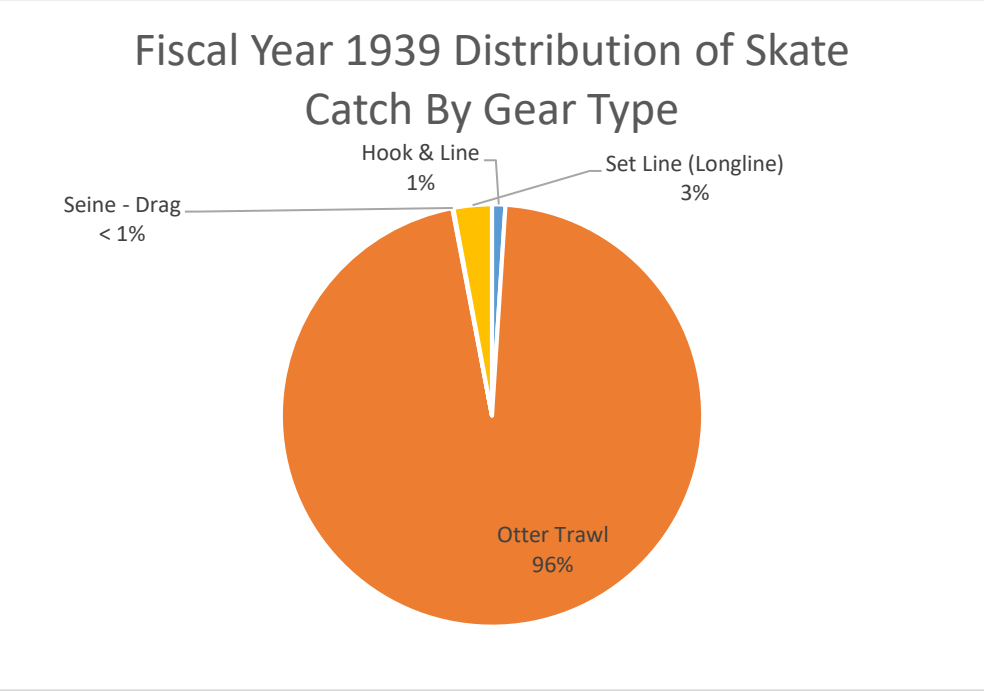
[1]Skate landings data are taken from Fishery Statistics of the United States

Gear

Landings of skate by gear type are found in both state and federal fishery statistical reports. There are two sources for state catch by gear; 1) Washington's Annual Statistical Reports in the All Districts Groundfish Landings by Gear-In number of pounds table, and the 2) Puget Sound focused Yellow book series. A look at two snapshots in time give the trend of the shift in types of gear landing skate. Figure 7 & 8 provide a quick look at the trend in gears reported to retain skate for sale.

Figure 11 Proportions of Gear Used in Puget Sound Landing Skate in 1925 (U.S. fishery statistics)





As early as 1939, the shift from a bycatch of the salmon gear to the almost exclusive contribution landings by otter trawl. This trend of catches primarily caught by otter trawl continued on through the 80's and 90's with minor contributions by other gear types such as hook and line or gillnet.

Species Composition

While at least three or four species are found in the Puget Sound, literature commonly reports that only two species were landed for commercial purposes, the Big Skate (*Raja binoculata)* and the Longnose Skate (*R. rhina)* (1942 Chapman) (1964 Alverson), (Canadian Fisheries and Oceans 2014) The Starry Skate (*R. stelata)* (1942 Bonham and Titus) is also recorded in the reduction catches and due to size may be part of the those fish destined for the reduction portion of the catch at $5 a ton. No mention of a fresh market for human consumption was found in any of the literature researched.

At present we only have species composition for 2015 to the present. Species compositions for reduction/meal and animal food taken in 1967 do not breakout by genus and species but are simply identified as 491 "Skate".

Discard- Survival Rates

The objective of this project is to estimate the catch of skates by species. Our ability to assign some estimate is based on few catch composition samples between 2015 and 2018. In research and in the monitoring of the commercial fisheries, catches of big and longnose skate are merged. As a result we cannot say what breakout was for these two species.

After looking over the published and internal literature, with any mention of skate, it is my opinion that the landings are a very small proportion of the skate mortality in commercial fisheries. Puget Sound catches averaged between 200 and 500 lbs per tow. Given the high mortality rate for skate, this represents a considerable number far over the amount harvested.

The earliest record found identifying Skates as discard was from the halibut fishery

> "*True cod are found in largest numbers where the depletion of halibut is most pronounced; and deep-sea soles, flounders, and skates are most numerous on a muddy bottom. It is certain that the total quantity of these fishes at present watered is enormous in the aggregate; in weight is probably at least one-half of that of the halibut itself."*

(Smith 1914). While most records with weights are of discard from Puget Sound, we have records of onboard observations in coastal waters that record skate as a discarded species. Skates are identified skates a primarily fished for the Vitamin A in their livers. Few references identify skate as a retained species. The 1948 WDF annual statistical report.

> The species of fish taken by otter trawling methods are varied and only a part of the catch is salable. True cod, ling cod, black cod, sole, flounders, dogfish, and several species of rockfish make up the salable portion of the catch. Skates, hake, pollack, ratfish, turbot, sculpins, and many other species are often encountered in numbers, but discarded. The sole, flounders, rockfish and true cod are iced and delivered in the round; the ling cod and black cod are dressed and iced for sale. The livers are removed from the dogfish

Multiple studies of European and United States east coast species with estimates of individual survival rates for east coast species are available (Rudders et al. 2015). Canadian estimates for the Northeastern Pacific Northwest coast species *R. Rhina* and *R. binoculata* ranged from 10% (hook and line fisheries) to 50% trawl fisheries (King et al. 2014)..

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