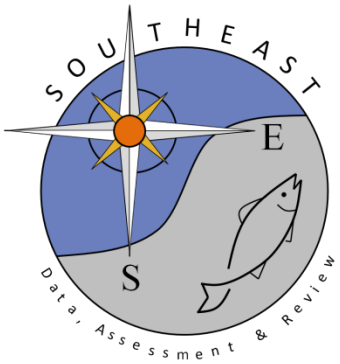
Procedure for allocating king mackerel (*Scomberomorus cavalla*) landings by fishing gear in the southern Gulf of Mexico

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MEXICAN INSTITUTE FOR SUSTAINABLE FISHERIES AND AQUACULTURE RESEARCH

DIRECTORATE OF FISHERIES RESEARCH IN THE ATLANTIC

"Implementation of the Strategic Action Program of the Gulf of Mexico Large Marine Ecosystem" Project

Procedure for allocating king mackerel (*Scomberomorus cavalla*) landings by fishing gear in the southern Gulf of Mexico

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Abstract

In the Gulf of Mexico, official king mackerel (*Scomberomorus cavalla*) landings are not recorded according to the gear with which the fish were taken. This document therefore describes the procedure used to allocate the annual catch between the artisanal gillnet and trolling fleets. Total catches come from the fisheries and aquaculture statistical yearbooks of the Comisión Nacional de Acuacultura y Pesca (CONAPESCA), the agency responsible for compiling official landings in Mexico. The allocation by gear was estimated from 14,924 field logbook records of S. *cavalla*, in which the fishing gear is noted directly, collected during the sampling programs carried out by the Mexican Institute of Fisheries and Aquaculture Research (IMIPAS). From these records the proportion of catch taken by each gear was estimated and applied to the official total. The hook-and-line fleet was found to account for close to 90 % of the catch.

1. Scope

1.1 Total catches

The statistical year books of the Comisión Nacional de Acuacultura y Pesca (CONAPESCA) was compiled for 1970–2025, and from it the monthly catch of king mackerel (*Scomberomorus cavalla*) landed by the artisanal fleet along the coast of the Gulf of Mexico and the Caribbean Sea was extracted for the years in which this statistic was available and grouped by fishing year (1 July to 30 June). Because live weight is missing for 2021, landed weight was converted using a factor of 1.0072, estimated from the 29 years in which the yearbook publishes both bases for the Gulf. This step was necessary because the 2021 live-weight table repeats the exact values of 2020.

1.2 Field logbooks

A total of 14,924 field logbook records were compiled from the fish-buying establishments and fishing cooperatives of several landing sites in Tamaulipas, Veracruz, Tabasco and Campeche, in which the king mackerel catch was recorded together with the gear noted and, depending on the gear, the mesh size, the number and length of net panels, the type and number of hooks, the number of lines, the number of fishers and the days at sea. In all they amount to 635.9 t of king mackerel, between 1996 and 2025, across 25 landing sites and 46 fish-buying establishments. The number of records by gear and the catch of each is shown in Table 1.

Table 1. King Mackerel catch recorded in logbooks, by the gear noted.

Gear	Records	kg of king mackerel	% of kg
Trolling	11,553	468,067	73.6 %
Gillnet	1,402	82,465	13.0 %
Handline	464	41,426	6.5 %
Longline	349	5,911	0.9 %
Other or mixed gear	45	216	0.0 %
No gear noted	1,111	37,831	5.9 %

At each landing site, the fish-buying establishments and cooperatives considered most representative of fishing activity were selected. From each selected establishment, as many logbooks as possible were obtained in which operations landing king mackerel had been recorded, with the gear noted in the field and the volume caught. The logbooks are a daily, per-fisher record kept by the fish-buying establishment or cooperative, in which all day's landings are entered for each vessel skipper, to control the volume landed and therefore the payments to the fishers. Table 2 presents the shares describing the gear composition of the establishments included.

Table 2. Gillnet share by state and the logbook coverage behind it.

State	Gillnet share	Records	kg of king mackerel	Period	Landing sites	Establishments
Veracruz	0.061	10,078	306,747	2006–2025	8	11
Tabasco	0.053	2,551	193,978	2016–2025	7	13
Tamaulipas	0.018	791	44,477	2000–2024	4	5
Campeche	1.000	348	52,667	2015–2025	4	6
Yucatan	no logbooks	—	—	—	—	—
Quintana Roo	no logbooks	—	—	—	—	—

Because the fish-buying establishments included represent a window onto the fishery rather than a census of it, what is carried across to the state is the gear composition, not the volume of catch.

2. Procedure

2.1 Gillnet share by state

For each state, the gillnet share was calculated as the ratio between the kilograms of king mackerel taken with gillnet and the kilograms of king mackerel with a gear noted. The ratio was computed on catches and not on the number of trips. In the case of Campeche, king mackerel is taken almost entirely with gillnets, owing to the shallow depth of the fishing grounds and to the preference of local fishers for nets in the coastal zone. The value of 1.000 is the composition observed in the fish-buying establishments of the Laguna de Términos region, and it was adopted for the state.

2.2 Weighting by the catch of each state

The state shares were weighed by the king mackerel catch of each state each year, according to the official records of the yearbooks, which yields the Gulf gillnet share for each year

2.3 Contribution of each state to the Gulf catch

During 2015–2025, Veracruz and Tabasco together accounted for close to three quarters of the catch, so that the Gulf gillnet share is determined in large part by these two states, both of which have logbooks and low, well-sampled shares. The two states without logbooks (Yucatán and Q. Roo) contribute on average 11.8 % of the total (Table 3, Figure 1).

Table 3. Contribution of each state to the king mackerel catch of the Gulf.

State	Mean	Minimum	Maximum	Mean 2015–2025
Veracruz	46.1 %	25.4 % (2013)	70.5 % (2022)	49.4 %
Tabasco	27.4 %	9.8 % (2022)	48.3 % (2006)	21.7 %
Yucatan	9.0 %	3.9 % (2017)	15.4% (2019)	8.1 %
Tamaulipas	8.3 %	3.3 % (2000)	23.0 % (2020)	12.0 %
Campeche	6.3 %	2.9% (1998)	12.9 % (2014)	6.5 %
Quintana Roo	2.8 %	0.6 % (2002)	5.0 % (2004)	2.2 %

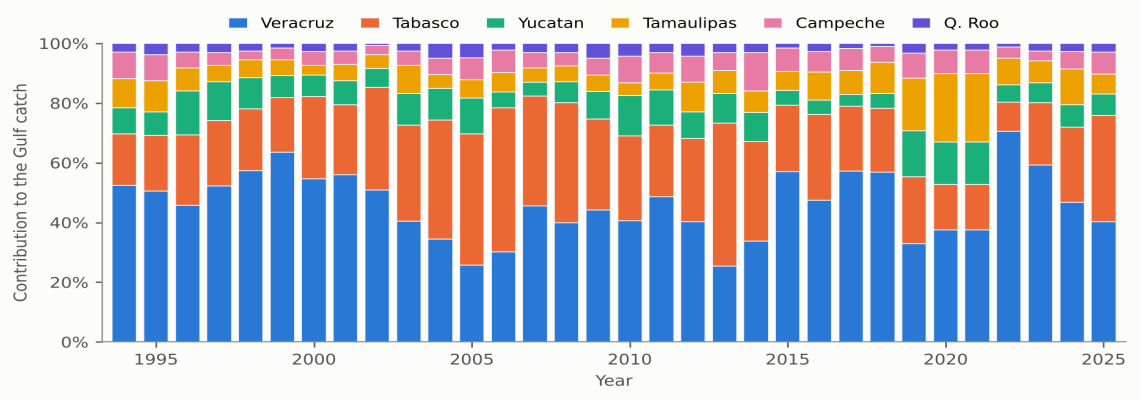


Figure 1. Contribution of each state to the king mackerel catch of the Gulf of Mexico and the Caribbean, 1994–2025. The two states without logbooks, Yucatán and Quintana Roo, together account for an average of 11.8 % of the catch, with a minimum of 5.7 % in 2017 and a maximum of 18.7 % in 2019.

3. Methodological basis

The ratio was computed over the full set of records of the establishments included, so that it describes the gear composition of those establishments. Standard FAO practice for small-scale fisheries follows this same logic. The handbook on sample-based fishery surveys (Stamatopoulos 2002) and the ARTFISH system derived from it stratify the fishery by fishing unit, a category of vessel and gear, and estimate the catch of each species as a fraction of the stratum total, using the proportion observed in the samples. The difference from what is described here is one of orientation, in that FAO divides a stratum total among species whereas this work divides a species total among gears.

In catch reconstruction, the Sea Around Us methodology (Zeller and Pauly 2016) explicitly contemplates subdividing over-aggregated official categories using composition data from sampling, together with the use of anchor points and expansion factors when the information available covers only part of a country. The case treated here is that of an aggregated official category subdivided with composition data, the difference being that the composition is by gear and not by species.

There are also recent precedents for disaggregating historical series in stock assessment. Gertseva et al. (2024) separate the historical catches of two skate species of the northeastern Pacific that were recorded under a single aggregated category, combining fishery-dependent and fishery-independent information. The problem is formally the same: an aggregated official series and a smaller auxiliary source that informs the partition.

4. Results

The Gulf gillnet share ranges between 0.08 and 0.17 in the years with a state breakdown, with a mean of 0.105. The dominant uncertainty does not come from the method but from the two states without logbooks: treating Yucatán and Quintana Roo as gillnet rather than hook-and-line raises that mean to 0.234.

Applied to the yearbook totals, the allocation produces the series in Figure 2. Between 1970 and 2024 the hook-and-line fleet averaged 3,034 t a year, with a minimum of 765 t in 1977 and a maximum of 6,697 t in 2018; the gillnet fleet averaged 357 t, with a minimum of 89 t in 1977 and a maximum of 786 t in 2015. The annual breakdown by fishing gear is given in Annex 1.

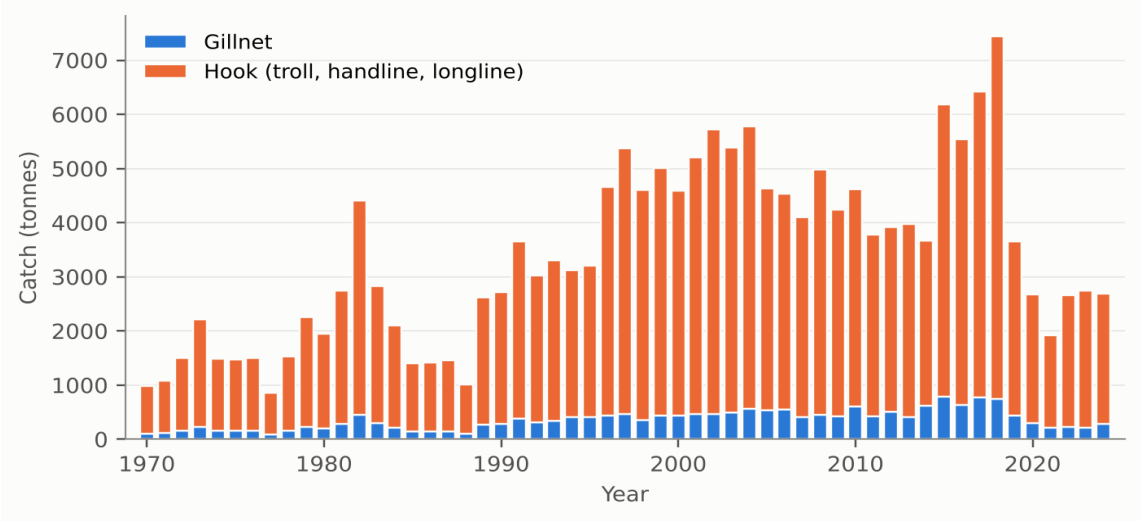


Figure 2. King mackerel catch in the Gulf of Mexico allocated by fishing gear, 1970–2024. The annual totals come from the yearbook; the partition between gears is the one estimated in this document.

5. Limitations

- Yucatán and Quintana Roo have no logbooks and contribute on average 11.8 % of the catch, ranging from 5.7 % to 18.7 % depending on the year. This is by some margin the largest source of uncertainty in the allocation.
- The Campeche share rests on 348 records from 4 landing sites, all in the Laguna de Términos area. It is the most extreme and the least supported of the four.
- The gear composition of the sampled landing sites is assumed to represent the state.
- Coverage by fish-buying establishment and by year is discontinuous: Veracruz has no records between 2021 and 2024.
- The allocation affects the distribution of the catch between fleets; it does not change the total, which is the yearbook figure.

6. Methods evaluated and discarded

Inferring the gear from the species composition of the official landing declarations (avisos de arribo) was evaluated, by means of k-means clustering on presence/absence and a logistic model of the Stephens and MacCall type. The procedure proved inapplicable, for two reasons for

different kinds.

- Clustering into two classes did not separate fishing gears. It separated grouper, lane snapper, red snapper and porgy on one side from amberjack, snook, drum, spanish mackerel and mullet on the other, which is the distinction between the reef and bank fishery and the coastal-estuarine one, that is, habitat and not gear.
- A landing declaration does not correspond to a fishing trip. Records containing king mackerel hold 5.9 species on average, none reports king mackerel as the sole species, and even those covering a single day of fishing average 6.4 species. They are the aggregated production of an economic unit, with several gears mixed in a single form, so that the species composition of the record cannot identify a gear.

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Annex. Annual catch by calendar year and by fishing year

The fishing year runs from 1 July to 30 June and is labeled by the year in which it begins. The years 1970–1979 and 1982–1988 are missing, because in those volumes king mackerel does not appear in any monthly table and falls within "other species". The 1984 volume is not present in the collection.

In the gillnet and hook-and-line columns, the fishing-year total was divided using the same procedure described above but applied to the twelve months that make up each fishing year rather than to the calendar year.

Table A1. King mackerel catch of the Gulf of Mexico and the Caribbean by calendar year and by fishing year, in tons. The first pair of gillnet and hook-and-line columns belongs to the calendar year and the second to the fishing year.

Year	Calendar year (t)	Gillnet (t)	Hook-and-line (t)	Fishing year	Fishing year (t)	Gillnet (t)	Hook-and-line (t)
1970	987	102	885	—	—	—	—
1971	1,087	113	974	—	—	—	—
1972	1,496	155	1,341	—	—	—	—
1973	2,220	230	1,990	—	—	—	—
1974	1,487	154	1,333	—	—	—	—
1975	1,472	153	1,319	—	—	—	—
1976	1,498	155	1,343	—	—	—	—
1977	854	89	765	—	—	—	—
1978	1,535	159	1,376	—	—	—	—
1979	2,249	233	2,016	—	—	—	—
1980	1,946	202	1,744	1980/81	1,849	192	1,657
1981	2,740	284	2,456	1981/82	4,143	430	3,713
1982	4,401	456	3,945	—	—	—	—
1983	2,830	293	2,537	—	—	—	—
1984	2,097	217	1,880	—	—	—	—
1985	1,404	146	1,258	—	—	—	—
1986	1,412	146	1,266	—	—	—	—
1987	1,462	152	1,310	—	—	—	—
1988	1,018	106	912	—	—	—	—
1989	2,618	271	2,347	1989/90	2,850	296	2,554
1990	2,712	281	2,431	1990/91	2,252	234	2,018
1991	3,652	379	3,273	1991/92	4,036	419	3,617
1992	3,026	314	2,712	1992/93	3,368	349	3,019
1993	3,300	342	2,958	1993/94	3,005	361	2,644
1994	3,126	413	2,713	1994/95	3,373	440	2,933
1995	3,213	416	2,797	1995/96	4,073	426	3,647
1996	4,661	439	4,222	1996/97	5,157	460	4,697
1997	5,369	464	4,905	1997/98	4,962	399	4,563
1998	4,598	350	4,248	1998/99	4,631	389	4,242

Year	Calendar year (t)	Gillnet (t)	Hook-and-line (t)	Fishing year	Fishing year (t)	Gillnet (t)	Hook-and-line (t)
1999	5,002	441	4,561	1999/00	4,938	454	4,484
2000	4,595	434	4,161	2000/01	4,777	439	4,338
2001	5,199	471	4,728	2001/02	5,699	485	5,214
2002	5,717	468	5,249	2002/03	5,392	474	4,918
2003	5,384	495	4,889	2003/04	5,692	568	5,124
2004	5,780	569	5,211	2004/05	5,247	559	4,688
2005	4,636	534	4,102	2005/06	4,660	564	4,096
2006	4,538	547	3,991	2006/07	3,852	395	3,457
2007	4,103	407	3,696	2007/08	4,496	414	4,082
2008	4,976	451	4,525	2008/09	4,820	467	4,353
2009	4,238	428	3,810	2009/10	4,629	594	4,035
2010	4,613	603	4,010	2010/11	3,859	410	3,449
2011	3,784	424	3,360	2011/12	3,831	528	3,303
2012	3,916	503	3,413	2012/13	3,881	407	3,474
2013	3,976	410	3,566	2013/14	3,667	510	3,157
2014	3,668	617	3,051	2014/15	4,898	796	4,102
2015	6,179	787	5,392	2015/16	6,159	677	5,482
2016	5,541	632	4,909	2016/17	5,742	717	5,025
2017	6,417	772	5,645	2017/18	7,670	762	6,908
2018	7,441	742	6,699	2018/19	4,921	554	4,367
2019	3,649	435	3,214	2019/20	3,126	324	2,802
2020	2,676	304	2,372	2020/21	2,673	304	2,369
2021	1,926	219	1,707	2021/22	2,449	215	2,234
2022	2,662	235	2,427	2022/23	2,719	201	2,518
2023	2,747	218	2,529	2023/24	2,817	268	2,549
2024	2,693	278	2,415	2024/25	2,705	279	2,426