

Laboratorio de Toxinas Marinas



Facultad de Medicina Universidad de Chile



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Impacts of Harmful Algal Blooms in Chile

IAEA Planning Meeting, Monaco 5-9 November 2001

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*South Pacific
Ocean*

*South Atlantic
Ocean*

Strait of Magellan

Tierra del Fuego



Hi Pix



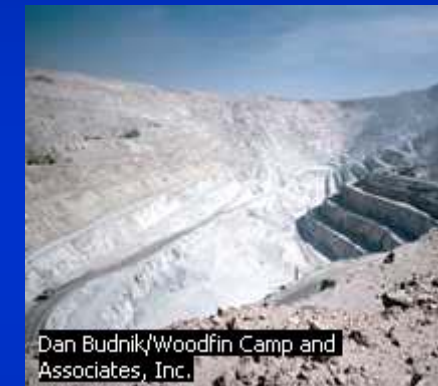
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Chile, republic in southwestern South America, bounded on the north by Peru, on the east by Bolivia and Argentina, and on the south and west by the Pacific Ocean.

It has an northern-southern length of approximately 4270 km (about 2650 mi), but its average width is less than 180 km (less than 110 mi).

The country has a total area of 756,626 sq km (292,135 sq mi).

The country's capital and largest city is Santiago

Archipelagoes extend along the southern Chilean coast from Chiloé Island to Cape Horn, the southernmost point of the South American continent.

Among these are the Chonos Archipelago, Guaitecas, Wellington Island, and the western portion of Tierra del Fuego.

Other islands belonging to Chile include the Juan Fernández Islands, Easter Island, and Sala y Gómez, all of which lie in the South Pacific.

In 2000 total annual exports were valued at \$16.0 billion.

Metals and mineral ores typically constitute nearly half of the export total.

Other important exports include fish, fish products, fruits and vegetables, wood pulp and paper products, and chemicals.

In 2000 imports were valued at \$15.9 billion. Principal imports are machinery and transportation equipment, electric equipment, mineral products, and chemicals.

Chile's chief trading partners for exports are Japan, the United States, Germany, the United Kingdom, Taiwan, Argentina, and Brazil.

Principal sources for imports are the US, Brazil, Italy, Argentina, and Germany.

Chile is a member of two international trade organizations including the Asia-Pacific Economic Cooperation (APEC), and the Latin American Integration Association (LAIA).

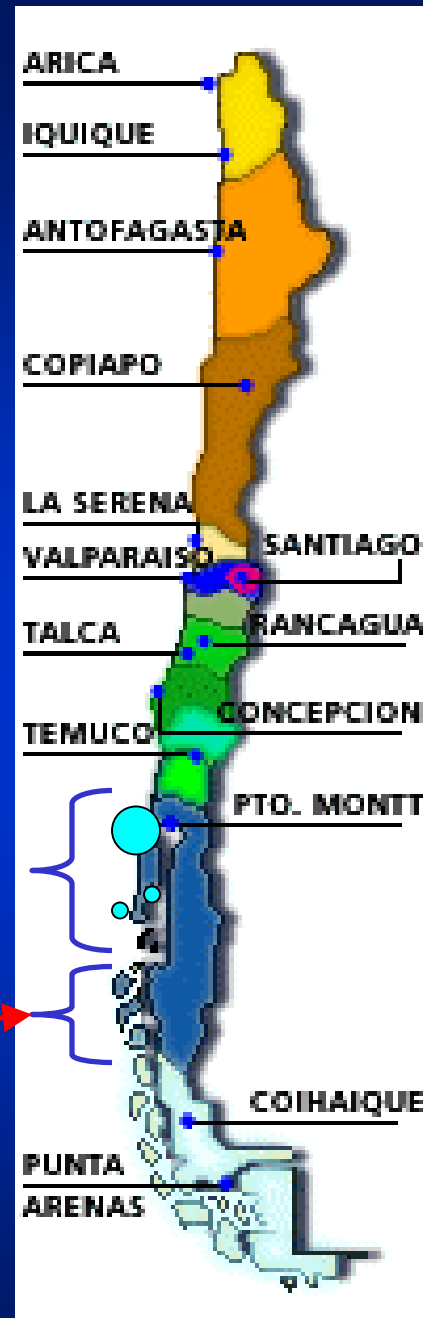
Chile is also an associate member of Southern Cone Common Market (known by its Spanish acronym, MERCOSUR).

Potential
Impacts of Harmful Algal Blooms on
Salmon & Trout production

Distribution of salmon & trout farms in Chile

Established sites

new leases



● Major blooms of *Heterosigma akashiwo* 1988, 2000

Salmon and Trout Exports

TOTAL CHILEAN EXPORTS

Millions of US Dollars Fob Chile

	1991	1992	1993	1994	1995	1996	1997	1998	1999
SALMON & TROUT	159	265	291	350	489	538	668	714	818
% Salmón & Trout	1.8%	2.6%	3.2%	3.0%	3.0%	3.5%	3.9%	4.8%	5.1%
% change		67%	10%	20%	40%	10%	24%	7%	15%
TOTAL CHILE	8,942	10,007	9,199	11,604	16,454	15,395	17,017	14,754	15,914
% change		12%	-8%	26%	42%	-6%	11%	-13%	8%

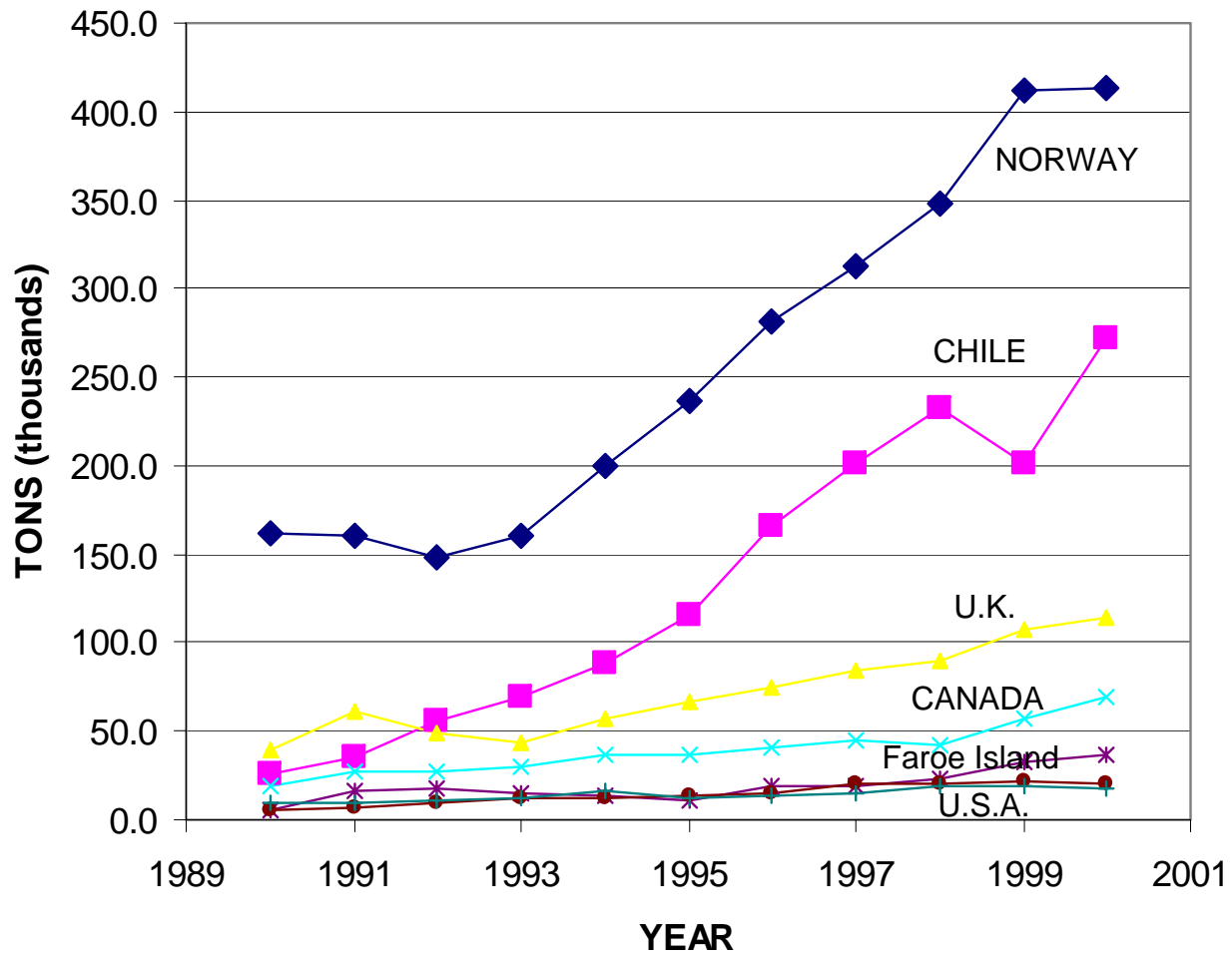
Asociación de Productores de Salmón y Trucha A.G.
(Chilean Association of Salmon and Trout Producers)

Exports from the fishing industry

	1991	1992	1993	1994	1995	1996	1997	1998	1999
fish mehl	465	540	366	453	633	612	552	349	282
%	42%	42%	31%	33%	36%	35%	29%	21%	16%
Salmon \$ Trout	159	265	291	350	489	538	668	714	818
%	14%	20%	25%	26%	27%	30%	36%	43%	46%
other	494	490	515	563	660	621	652	611	684
%	44%	38%	44%	41%	37%	35%	35%	37%	38%
Total	1,118	1,295	1,172	1,366	1,782	1,772	1,873	1,674	1,784
% Variación		16%	-9%	17%	30%	-1%	6%	-11%	7%

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SALMON AND TROUT PRODUCTION



RELEVANT FIGURES

- Direct employment to 22.000 persons
- Indirect employment to 10.000 persons
- Major export product from a southern region

Projections to year 2010

year	Net tons exported (thousands)				increase	Total Exports	average price
	atlantic	Coho	Trout	Total	Annual	(MUS\$)	(US\$/Kilo)
1996	56	45	36	137		538,302	3.93
1997	65	47	47	159	16.06%	668,471	4.20
1998	67	57	57	181	13.84%	713,572	3.94
1999	64	57	35	156	-13.81%	817,808	5.24
2000	90	63	45	198	26.92%	990,000	5.00
2001	108	70	52	230	16.16%	1,150,000	5.00
2002	129	73	58	260	13.04%	1,300,000	5.00
2003	155	77	64	296	13.85%	1,480,000	5.00
2004	178	81	67	326	10.14%	1,630,000	5.00
2005	205	85	70	360	10.43%	1,800,000	5.00
2006	236	90	74	400	11.11%	2,000,000	5.00
2007	271	91	77	439	9.75%	2,195,000	5.00
2008	304	94	81	479	9.11%	2,395,000	5.00
2009	340	96	85	521	8.77%	2,605,000	5.00
2010	375	100	90	565	8.45%	2,825,000	5.00

Asociación de Productores de Salmón y Trucha A.G.
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Leased aquaculture sites to year 2001

year	utilized leases	leases in rotation	Total leases
1998	291	54	345
1999	306	56	362
2000	368	67	435
2001	419	77	496
2002	474	87	561
2003	529	97	627
2004	586	107	693
2005	651	119	770
2006	717	132	849
2007	786	144	930
2008	856	157	1013
2009	919	168	1087
2010	960	173	1133

Asociación de Productores de Salmón y Trucha A.G.
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Impacts of Harmful Algal Blooms on
Shellfish Production and Public Health
in Chile

Syndrome

Microalgae

Toxin

Toxins that target the Na⁺ channel

Paralytic Shellfish Poisoning (PSP)

Dinoflagellates: *Alexandrium spp*

Saxitoxins

Neurotoxic Shellfish Poisoning (NSP)

Dinoflagellate: *Gymnodinium spp*

Brevetoxins

Ciguatera

Dinoflagellate: *Giamberdiscus toxicus*

Ciguatoxins

Other marine toxins

Diarrheic Shellfish Poisoning (DSP)

Dinoflagellates: *Dinophysis spp*

Okadaic Acid

Amnesic Shellfish Poisoning (ASP)

Diatoms: *Pseudonitzschia spp*

Domoic Acid

SYNDROMES CAUSED BY MARINE TOXINS THAT TARGET THE SODIUM CHANNEL PROTEIN

Paralytic shellfish poisoning (PSP) occurs in all coastal New England, Northeastern Canada as well as the west coast from Alaska to California, Chile. Causative species are: *Alexandrium tamarense*, *A. fundyense* and *A. catenella*.
Toxins: **saxitoxins**.

Neurotoxic shellfish poisoning (NSP) and fish mortalities in the Gulf of Mexico have extended recently to the coast of the Carolinas.
Causative species: *Gymnodinium breve* (now *Karenia brevis*).
Toxins: **brevetoxins**.

Ciguatera fish poisoning (CFP) is a syndrome associated with dinoflagellate toxins accumulated in tropical fish.
It occurs in virtually all sub-tropical to tropical U.S. waters (Florida, Guam, U.S. Virgin Island, Puerto Rico. Affects local residents and foreign tourists.
World-wide intoxication cases >25000.
Causative species: *Gyamberdiscus toxicus*.
Toxins: **ciguatoxins**.

MARINE TOXINS AND HARMFUL EFFECTS

Amnesic shellfish poisoning (ASP). This was observed first in southeastern Canada in 1987 (Prince Edward Island) with over 200 intoxicated persons. ASP is now a problem for the U.S. Pacific coast states since 1991, Ireland, Spain and Chile.

Causative species: diatoms of the *Pseudonitzschia* genus
Toxin: **domoic acid.**

Recurrent brown tides in Rhode Island are associated to mortalities of farmed fish.

Pfisteria piscicida has been implicated in human and fish toxic events in the state of Maryland, US.

WORLDWIDE ECONOMIC IMPACTS OF HABs and PSP

JAPAN: HABs kill finfish and shellfish in aquaculture sites. Total estimated losses up to > US\$ 150 million/year. 40% only from PSP.

MEXICO: 45% of environmental emergencies reported in 1996 were associated with toxic algal blooms with human PSP poisoning cases. Losses > US\$ 15 million in that year.

PHILIPPINES: 116 deaths in 1992 cases of PSP human intoxications between 1983 and 1998. Action level reduced to 40 ug STX/100g due to children mortalities. Losses over US\$ 10 million/year. Malaysia and Brunei report deaths every year

CHILE: 23 deaths in 324 cases of PSP intoxications reported since 1972. A third of the country coastal areas traditionally used for shellfish extraction are closed. Estimated losses >US\$ 40 million/year

Impacts of Harmful Algal Blooms on Shellfish Production and Public Health in Chile

Current shellfish exports potentially threatened by
harmful algal blooms

ca. US\$ 100 millions plus US\$ 30 millions domestic trade

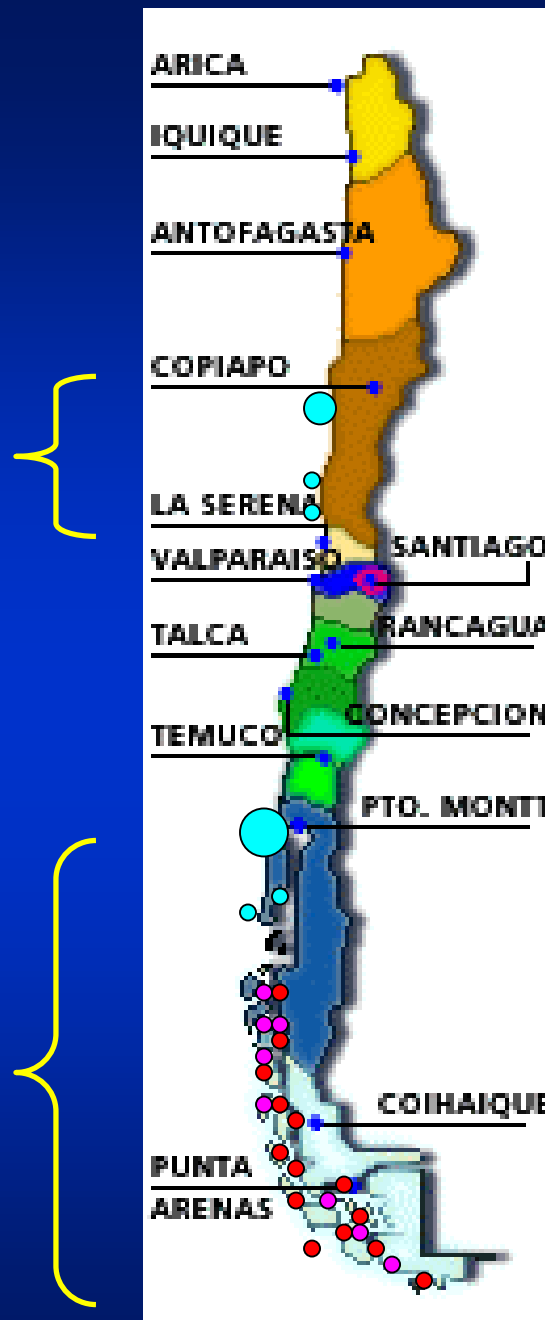
Preventive closures in southern Chile generate
ca. another US\$100 millions of estimated annual losses

Direct negative impact on local employment as
shellfish production is labor intensive

Distribution of marine toxins detected in Chile

Laboratory of Marine Toxins
University of Chile

IFOP Punta Arenas



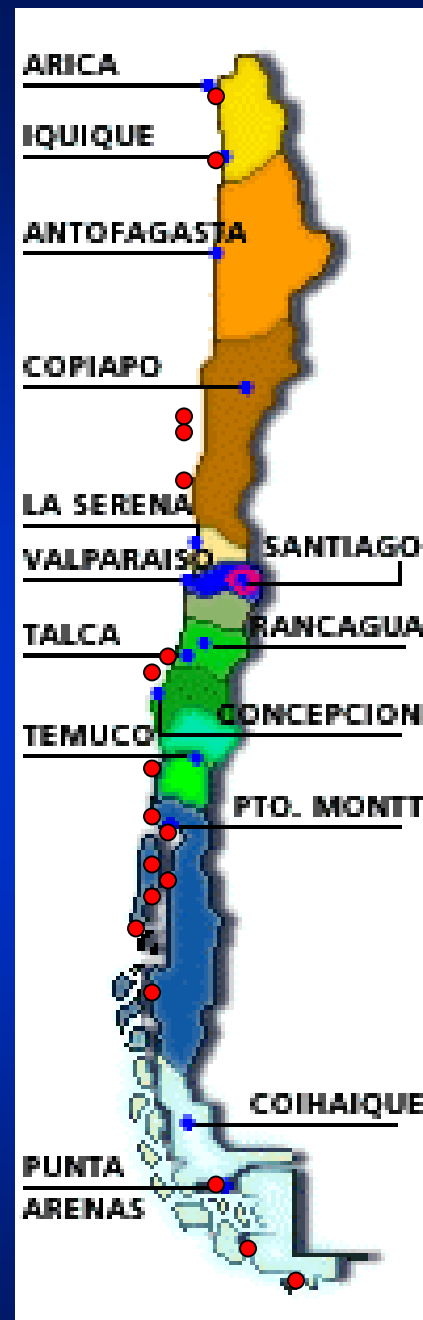
● ASP

● DSP

● PSP



Location of main aquaculture sites and processor plants



Export of shellfish species that may affected by HABs (MUS\$)

	Recurso	1995	1996	1997	1998	Ene-Jun 1999	Total
*	LOCO	24,098	15,417	21,724	14,245	764	76,248
**	OSTION DEL NORTE	10,497	8,421	12,007	21,382	10,764	63,070
	NAVAJA DE MAR O HUEPO	10,128	10,717	10,295	9,302	6,260	46,701
*	ALMEJA	8,179	9,746	7,764	9,048	4,599	39,334
	CULENGUE-ALMEJA	10,005	9,590	9,517	4,440	3,458	37,010
	LAPA	4,726	5,219	6,473	6,125	3,979	26,520
*	MACHA	3,803	3,547	4,873	4,969	1,205	18,397
	NAVAJUELA	3,110	4,342	4,831	4,454	1,136	17,873
	CHORITO	1,652	1,640	2,072	3,599	2,786	11,750
	OSTION DEL SUR	1,532	1,751	3,231	3,675	1,145	11,336
	CARACOL LOCATE	1,065	1,016	1,670	1,155	389	5,294
	TUMBAO	121	559	138	736	396	1,950
	CARACOL TROPHON	212	225	626	137	100	1,300
	CARACOL TRUMULCO	243	262	71	324	35	935
	CHOLGA	232	164	193	201	109	898
	CARACOL PIQUILHUE			395	56		451
	CARACOL PALO PALO	32	243	119	0		394
	TAQUILLA	30	51	89	73	55	299
	OSTRA CHILENA	3	35	45	34	8	125
	CARACOL PICUYO	0	106				106
	PICOROCO	0	18	0	0	1	19
	CHORO	0	7	2	8		17
	PIURE	0	8	2	2	1	14
	Total general	79,667	73,083	86,136	83,965	37,188	360,039

SCOPE OF THE PROBLEM

A country with 4000 km of longitudinal coast
but 30000 km of total coastal line

Two southern regions (Aysen and Magallanes)
under complete closure for shellfish harvest since 1994

Largest natural shellfish beds

Isolated unpolluted areas

Estimated annual losses in excess of 100 million US\$
due to closures for shellfish harvest and/or aquaculture

Chilean institutions involved in sanitary control for export of seafood products.

Servicio Nacional de Pesca (National Fisheries Service). Depends from the Ministry of Economy. Oversees all seafood products and other commodities. It is the recognized counterpart to control the enforcement of bilateral trade agreements regarding potentially toxic shellfishes with the EEC (Directives 91/492 and 493) the US (National Shellfish Sanitation Program, NSSP).

It has established QC norms for productive processes in plants (ISO 9000) and monitoring programs for marine toxins, heavy metals, *E. Coli* and other intoxicants.

Certified supporting laboratories.

- Laboratory of Marine Toxins at the University of Chile
- Laboratory of Red Tides of the Instituto de Fomento Pesquero Punta Arenas
- Plancton Andino, Puerto Montt
- Laboratory of Environmental Science, Universidad Austral, Puerto Montt,
- Institute of Oceanology of Valparaíso
- Catholic University of Valparaíso,
- Instituto de la Patagonia, Punta Arenas

Chilean institutions involved in domestic sanitary control

Ministry of Health. Oversees Regional Health Services(Hanta virus, HAB outbreaks).

There is a ***National Red Tide Management Plan.***

Includes administrative norms contained in the Sanitary Code.

Regional Health Services. Autonomous units. Enforce local closures, can seize batches, close processor plants and markets.

Analyze toxins in shellfish using the AOAC mouse bioassay

Institute of Public Health. National reference laboratory. Certifies external laboratories.

IMPACTS ON PUBLIC HEALTH OF HARMFUL ALGAL BLOOMS IN CHILE

Paralytic Shellfish Poisoning (PSP)

Causative species: *Alexandrium catenella*
(26 deaths and 348 intoxicated persons since 1972)

Diarretic Shellfish Poisoning (DSP)

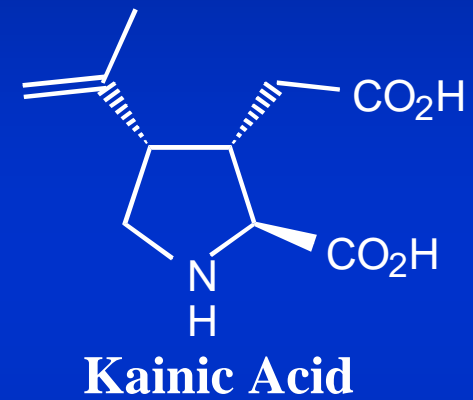
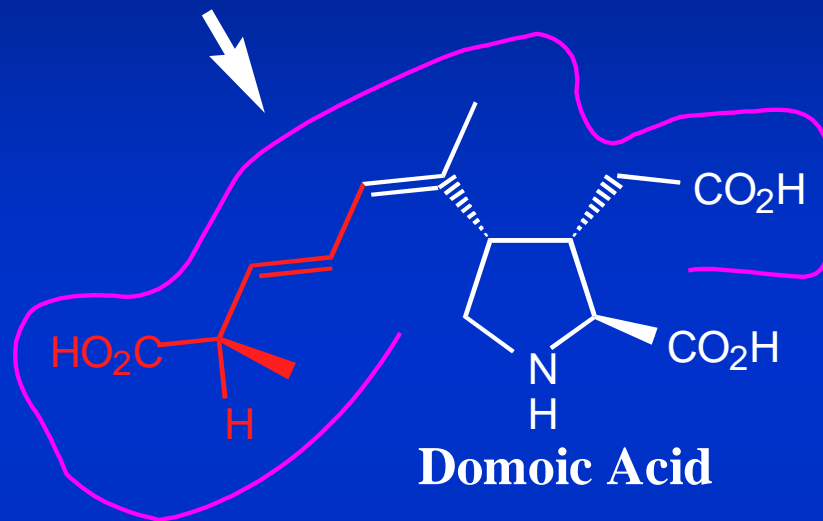
Causative species: *Dinophysis acuta*
more than 800 registered cases

Amnesic Shellfish Poisoning (ASP)

Causative species: diatoms *Pseudonitzschia spp.*
No registered cases

One third of total coastal areas closed due to persistent presence of PSP and DSP. Estimated annual losses >US\$ 100 millions.

Impacts and lessons from outbreaks of
Amnesic Shellfish Poison



DA is regulated world wide at 20 ug/g

KA and glutamate are unregulated

Areas where Amnesic Shellfish Poison has been detected

Bahía Inglesa
La Serena

Island of Chiloé



● Aquaculture sites