

Update on IATTC climate change work

IATTC Staff



1st Climate Change Workshop – 23-26 February 2025 virtual conference.

Background

INTER-AMERICAN TROPICAL TUNA COMMISSION

101st MEETING

Victoria, B.C., Canada 7-11 August 2023

RESOLUTION C-23-10

ON CLIMATE CHANGE

- 1. The IATTC scientific staff will highlight and consider the best scientific information available on the relationships between climate change, target stocks, non-target species, and species belonging to the same ecosystem or associated with the target stocks."
- 2. The scientific staff shall incorporate in the next edition of the science strategic plan the issue of climate change and its impact on target species, non-target species, and the EPO ecosystem in general.
- 3. The Commission in 2024 and annually thereafter shall include climate change as an agenda item at the ordinary annual meeting of the IATTC.



Environmental Database





~10,000 daily layers: Jan 01, 1995 – Dec 31, 2023 (spatial resolution 0.10 – 0.25°)

14 Dynamic Variables

Surface

- SST
- SST gradient
- Surface salinity
- Current speed
- Current direction
- Eddy kinetic energy
- Finite size Lyapunov exponent (FSLE)
- Front index
- Chlorophyl
- Chlorophyl gradient Subsurface
- Temp 100 meters
- Mixed layer depth
- Bulk frequency
- Isothermal layer depth







Environmental Database

A	B		с	D	E	F	G	н	1	J	к	L	M	N	0	P	Q	R	5
Date	Lat	b	on	sst	sst_grad	sst_100	Sal	Vel	Vol	Dir_cor	EkE	SSH	Mlp	Chl	chl_grad	ILD	BF	FSLE	FrontIndex
3/24/2019	2	2.5	-107.5	23.177	0.662	14.373	34.869	0.118004	-0,18058	253,2542	0.006963	0.212	27.09996	0.102067	-0.0043	22.12135	0.010526	0	0.125
3/24/2019	2	3.5	-108.5	22.179	-0.143	15,731	34,785	0.187779	0.047271	304.3671	0.017631	0.238	42,79996	0.097132	0.004068	16.67373	0.01	0	NA
3/24/2019	2	3.5	-107.5	22.15	0.54	13.993	34.461	0.13813	-0.04211	177.5104	0.00954	0.211	28,79996	0.112078	-0.0092	23.59621	0.009837	0	NA
3/24/2019	1	5.5	-106.5	28.133	0.595	19.067	33.775	0.177496	-0.0256	262.5547	0.015753	0.512	62.69996	0.080964	0.001259	42,45239	0.013476	-0.04924	3.625
3/24/2019	1	5.5	-105.5	28,506	0.931	17.713	33.87	0.16183	-0.04085	257.5096	0.013095	0.451	49.99996	0.160004	0.03134	40.70149	0.01349	-0.0195	4.25
3/24/2019	1	6.5	-105.5	27.748	0.642	16.116	34,249	0.253269	-0.0181	319.6441	0.032073	0.397	39,39996	0.094943	0.001287	26.67935	0.01299	-0.04241	7.375
3/24/2019		4.5	-125.5	28.44	-0.058	23.597	34,446	0.2449	-0.0565	30.96376	0.029988	0.417	15.89996	0.162122	-0.00358	57.56144	0.012982	-0.02435	NA
3/24/2019	1	3.5	-93.5	29.959	0.165	12.946	34.13	0.220676	0.099103	150.9958	0.024349	0.229	17.09996	0.244009	-0.05215	4.019682	0.012654	0	0.25
3/24/2019	1	4.5	-94.5	28.372	0.064	14.33	34.09	0.058524	-0.35545	213.147	0.001713	0.227	14.19996	0.274333	-0.04039	8.714953	0.011638	-0.08667	0.5
3/24/2019	1	4.5	-93.5	29.791	0.226	14.216	33.88	0.131939	-0.0161	14.03624	0.008704	0.289	13.99996	0.170491	-0.04517	6.4582	0.012552	-0.22367	NA
3/24/2019	1	3.5	-94.5	28.903	0.784	13.588	34.188	0.175559	0.078342	175.4261	0.015411	0.164	9.699955	0.319623	-0.24541	7.465722	0.01193	0	1.125
3/24/2019	1	4.5	-95.5	26.438	-0.668	15.214	34.229	0.378356	0.011783	242.9609	0.071577	0.323	40.79996	0.403295	0.075507	13.04	0.011164	0	1.375
3/24/2019	1	4.5	-94.5	28.372	0.064	14.33	34.09	0.058524	-0.35545	213.147	0.001713	0.227	14.19996	0.274333	-0.04039	8.714953	0.011638	-0.08667	0.5
3/24/2019	1	7.5	-106.5	26.688	0.631	15.022	34.586	0.103812	0.318423	35.9868	0.005389	0.315	35.59996	0.106597	0.006415	35.92428	0.011543	-0.06503	5
3/24/2019	1	7.5	-105.5	26.166	0.009	15.341	34,304	0.25607	0.125903	313.4176	0.032786	0.315	32,89996	0.107054	0.005972	25.59744	0.01185	-0.02287	4.875
3/24/2019	1	5.5	-110.5	27.892	0.361	18.92	33.565	0.163368	-0.08168	124.2737	0.013345	0.515	61.79996	0.150978	-0.00648	28.56352	0.013668	-0.0201	2.5
3/24/2019	1	5.5	-109.5	28.225	0.446	20.114	33.702	0.200898	-0.16191	43.38646	0.02018	0.543	59,59996	0.106507	-0.0187	28.09146	0.013994	-0.04975	8.25
3/24/2019	1	6.5	-110.5	26.521	-0.06	18.228	33.831	0.264282	0.107528	354.3541	0.034923	0.464	55.29996	0.105558	-0.01867	48.68672	0.012347	-0.0308	3
3/24/2019	1	6.5	-109.5	26.748	0.091	17.769	33.929	0.297742	-0.08641	347.7843	0.044325	0.425	54,39996	0.125764	-0.00275	48.09894	0.01243	-0.03835	8
3/24/2019		3.5	-84.5	30.204	2,511	15.983	33.395	0.536681	-0.02239	163.6587	0.144013	0.311	9.899955	0.317679	0.01546	9.45085	0.012627	-0.02147	6.5
3/24/2019	-	0.5	-95.5	27.104	0.314	14.838	34.485	0.301228	-0.139	135	0.045369	0.299	4.899955	0.256617	0.003972	18.33231	0.011922	0	2.25
3/24/2019		0.5	-95.5	27.555	0.339	16.073	34.407	0.454736	0.068002	135.9801	0.103393	0.299	4.599955	0.264539	0.014003	10.11345	0.011971	0	9.5
3/24/2019	1	6.5	-107.5	26.968	-1.056	16.236	34.101	0.18685	-0.10739	22.99727	0.017457	0.375	40.29996	0.084838	-0.00224	43.61944	0.012922	-0.0227	2.625
3/24/2019	1	7.5	-107.5	25.925	-0.189	14.075	34.52	0.013928	0.370304	68.96249	9.70E-05	0.257	39.89996	0.101322	0.003914	36,462	0.011881	-0.11734	4.125
3/24/2019	1	8.5	-107.5	25.518	0.221	15.39	34,523	0.10387	-0.08956	246,1495	0.005395	0.316	42,89996	0.105866	0.00299	26.79731	0.011904	-0.08388	9.25
3/24/2019	1	6.5	-108.5	26.725	-0.557	17.407	33.959	0.395471	0.117049	344.4526	0.078199	0.397	51.09996	0.066882	0.000846	44.59684	0.012817	-0.08602	8.375
3/24/2019	1	7.5	-108.5	26.181	0.373	14.325	34.372	0.141739	0.176134	290.2249	0.010045	0.28	34.29996	0.086658	0.003627	36.2886	0.01209	-0.04066	1.25
3/24/2019	1	3.5	-93.5	29.959	0.165	12.946	34.13	0.220676	0.099103	150.9958	0.024349	0.229	17.09996	0.244009	-0.05215	4.019682	0.012654	0	0.25
3/24/2019	1	5.5	-111.5	27.341	0.775	17.615	33.4	0.23937	-0,12883	111.3125	0.028649	0.466	44.49996	0.101876	9.41E-05	31.66479	0.013535	-0.04725	1.75
3/24/2019	1	6.5	-111.5	26.532	0.039	17.523	33.867	0.252464	0.135681	69.84239	0.031869	0.42	30.99996	0.077193	-0.00528	34.55371	0.012995	-0.0259	0.625
3/24/2019	1	6.5	-110.5	26.521	-0.06	18.228	33.831	0.264282	0.107528	354.3541	0.034923	0.464	55.29996	0.105558	-0.01867	48.68672	0.012347	-0.0308	3
3/24/2019	1	3.5	-93.5	29.959	0.165	12.946	34.13	0.220676	0.099103	150.9958	0.024349	0.229	17.09996	0.244009	-0.05215	4.019682	0.012654	0	0.25
3/24/2019	1	2.5	-93.5	29.263	-0.072	12.456	34.117	0.332609	-0.1406	34.83679	0.055315	0.23	18.79996	0.332104	-0.38013	11.55218	0.012989	0	1.125
3/24/2019	1	3.5	-93.5	29.959	0.165	12.946	34.13	0.220676	0.099103	150,9958	0.024349	0.229	17.09996	0.244009	-0.05215	4.019682	0.012654	0	0.25
3/24/2019	1	0.5	-91.5	28.5	1.283	14.517	33.918	0.242421	-0.02941	322.3738	0.029384	0.255	7.899955	0.267066	0.004154	31.31502	0.012598	0	8.875

>600,000 observer program purse seine set data (1995-2023)

14 Dynamic Variables

- Surface
- SST
- SST gradient
- Surface salinity
- Current speed
- Current direction
- Eddy kinetic energy
- Finite size Lyapunov exponent (FSLE)
- Front index
- Chlorophyl
- Chlorophyl gradient Subsurface
- Temp 100 meters
- Mixed layer depth
- Bulk frequency
- Isothermal layer depth



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-150-130 -110 -90



Early Life History Program: Published Studies on Climate Change Effects on Tunas

Since 2011, the Early Life History Group of the IATTC has conducted studies of the effects of climate change on the pre-recruit life stages of YFT.

This research has utilized a combination of experimental and modeling studies conducted mostly at the Achotines Laboratory, and is focused on the effects of ocean warming, ocean acidification, hypoxia, and wind-induced microturbulence on the survival, growth, physiology and behavior of egg and larval stages of YFT.

Publications resulting from this research include:

Heuer, R.M., Y. Wang, C. Pasparakis, W. Zhang, V. Scholey, D. Margulies and M. Grosell. 2023. Effects of elevated CO2 on metabolic rate and nitrogenous waste handling in the early life stages of yellowfin tuna (*Thunnus albacares*). Comparative Biochemistry and Physiology, Part A 280: 111398. <u>https://doi.org/10.1016/j.cbpa.2023.111398</u>

Wexler, J.B., D. Margulies, V. Scholey, C. E. Lennert-Cody, D. Bromhead, S. Nicol, S. D. Hoyle, M. Stein, J. E. Williamson, J. Havenhand 2023. The effect of ocean acidification on otolith morphology in larvae of a tropical, epipelagic fish species, yellowfin tuna (*Thunnus albacares*). Journal of Experimental Marine Biology and Ecology 10.1016. <u>https://doi.org/10.1016/j.jembe.2023.151949</u>

Nicol, S., P. Lehodey, I. Senina, D. Bromhead, A. Frommel, J. Hampton, J. Havenhand, D. Margulies, P. Munday, V. Scholey, J. Williamson, and N. Smith. 2022. Ocean futures for the world's largest yellowfin tuna population under the combined effects of ocean warming and acidification. Frontiers in Marine Science 9: 816772. https://doi.org/10.3389/fmars.2022.816772

Heuer, R.M., Y. Wang, C. Pasparakis, V. Scholey, D. Margulies and M. Grosell. 2020. Effects of elevated CO2 on yellowfin tuna (*Thunnus albacares*) early life stage respiration and ammonia excretion. Journal of the Federation of American Societies for Experimental Biology 34(S1): 1-1. https://doi.org/10.1096/fasebj.2020.34.s1.09653

Frommel, A.Y., D. Margulies, J.B. Wexler, M.S. Stein, V.P. Scholey, J.E. Williamson, D. Bromhead, S. Nicol, and J. Havenhand. 2016. Ocean acidification has lethal and sub-lethal effects on larval development of yellowfin tuna, *Thunnus albacares.* J. Exp. Mar. Biol. Ecol. 482: 18-24. <u>https://doi.org/10.1016/j.jembe.2016.04.008</u>

Margulies, D., V. P. Scholey, J. B. Wexler, and M. S. Stein. 2016. Research on the reproductive biology and early life history of yellowfin tuna *Thunnus albacares* in Panama. Pages 77-144 In: Advances in Tuna Aquaculture, D. Benetti, G. Partridge, and A. Buentello (editors), Elsevier-Academic Press.

Bromhead, D., V. Scholey, S. Nicol, D. Margulies, J. Wexler, M. Stein, S. Hoyle, C. Lennert-Cody, J. Williamson, J. Havenhand, T. Ilyina, and P. Lehodey. 2015. The potential impact of ocean acidification upon eggs and larvae of yellowfin tuna (*Thunnus albacares*). Deep Sea Res. Part II, Top. Stud. Oceanogr.113: 268-279. <u>https://doi.org/10.1016/j.dsr2.2014.03.019</u>

Scholey, V., D. Bromhead, D. Margulies, S. Nicol, J. Wexler, M. Santiago, J.E. Williamson, S. Hoyle, P. Schlegel, J. Havenhand, T. Ilyina, and P. Lehodey. 2012. Novel research into the impacts of ocean acidification upon tropical tuna. Pelagic Fisheries Research Program Newsletter 16(1): 1-8.

Wexler, J.B., D. Margulies, and V.P. Scholey. 2011. Temperature and dissolved oxygen requirements for survival of yellowfin tuna, *Thunnus albacares*, larvae. J. Exp. Mar. Biol. Ecol. 404/65/12 7 Kimura, S., H. Nakata, D. Margulies, J. M. Suter, and S. L. Hunt. 2004. Effect of oceanic turbulence on the survival of yellowfin tuna larvae. Nippon Suisan Gakkaishi, 70: 175-178.

Early Life History Program: Future Research Related to Climate Change Effects on Tunas

The IATTC Early Life History Group, in collaboration with the Ecosystem and Bycatch, and Stock Assessment Groups, is developing a long-term research plan to investigate the effects of climate change on tunas. This research is ongoing and will be conducted mostly at the Achotines Laboratory in collaboration with La Jolla-based staff.

The studies are investigating the effects of climate change on the survival, growth, physiology, behavior and genetics of pre-recruit, juvenile and adult stages of tunas. Experimental results will be used to inform physical-biological interaction models to describe the effects of climate change on tunas.

Specific Topics of Study:

Effects of Ocean Warming on Larval YFT and PBF

- Ongoing studies, initiated in 2024, of the effects of thermally-limiting water temperatures (> 28°C) on the larvae of YFT and PBF (in collaboration with Kindai U)
- Possible interactive studies of the effects of ocean warming and ocean acidification on pre-recruit life stages of YFT (extending the experimental and modeling work of Nicol et al. 2022)

Effects of Ocean Acidification on Pre-Recruit Life Stages of YFT

- Extending the published work of the IATTC, in collaboration with academic colleagues, to investigate more-specific effects of ocean acidification on the survival, growth, physiology and genetics of late-larval and early-juvenile YFT
- Utilizing these experimental results to parameterize physical-biological interaction models for ocean acidification effects

Effects of Hypoxia on Larval and Early-Juvenile Stages of YFT

• Extending published work of the IATTC to investigate the effects of hypoxia (which usually accompanies ocean warming and acidification) on the larval and early-juvenile stages of YFT

Climate change proposed workplan



SAC-15-12

9





Climate change workshop TORs

INTER-AMERICAN TROPICAL TUNA COMMISSION

102nd MEETING

Panama, Panama 02-06 September 2024

IATTC-102 INF-B

TERMS OF REFERENCE FOR CLIMATE CHANGE WORKSHOPS

- TORs described in IATTC-102 INF-B
- Briefly presented at 102nd Meeting in Panama City at its request
- Was not discussed in detail or submitted as a proposal and thus not endorsed at the 102nd Meeting
- To start the workshop series we are following the principles and guidelines from the proposed TORs



Climate change proposed workplan



scientific staff

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Commission, and stakeholders Commission



Proposed Timeline

Phase	Activities		2024				2025				2026				2027				2028				2029			
Flidse			Q2	Q3	Q4	Q1	Q2	Q3	Q4																	
1) Planning	Review of and share available frameworks																									
	and tools																									
	Develop white paper of review and workplan																									
	proposal																									
	SAC/Comission Meeting: Share climate																									
	change resources and proposal with																									
	members																								L	
	Establish Terms of Reference (TOR) for																									
	climate change workshops																									
2) Decide on main																										
goal and scope	Workshop to develop main goal and scope																									
	SAC/Comission Meeting: Share/adopt main																									
2) Develop																										
3) Develop	Workshop to develop framework					_																				
framework	SAC/Comission Meeting: Share/adopt																									
A) Constituents also																										
4) Creating tools	Strategic tool development																									
	Workshop for sharing and developing strategic tools																									
	Tactical tool development																									
	SAC/Comission Meeting: Share newly																									
	developed strategic tools																									
	Workshop for sharing and developing																									
	strategic and tactical tools																									
	SAC/Comission Meeting: Share newly																									
	developed strategic and tactical tools																									
	Workshop to identify tactical tools and																									
	management action																									
Tool Implentation &	SAC/Comission Meeting: Recommend tool																									
Action2	implementation/ management action																									
	Implementation																									

CIA

Discussions for the workshop

- 1. Main Goal (Feb 24th)
 - External Speaker
 - <u>CC-01-01</u>
 - Preliminary Recommendation
- 2. Scoping (Feb 25th)
 - External Speaker
 - <u>CC-01-01</u>
 - Preliminary Recommendations
- 3. Framework (Feb 26th)
 - External Speaker
 - <u>CC-01-02</u>
 - Example frameworks
- Preliminary Recommendation

INTER-AMERICAN TROPICAL TUNA COMMISSION

1ST WORKSHOP ON CLIMATE CHANGE

La Jolla, California (USA) 24-26 February 2025 (by videoconference)

DOCUMENT CC-01-01

GOALS AND SCOPE OF THE IATTC CLIMATE CHANGE WORKPLAN

INTER-AMERICAN TROPICAL TUNA COMMISSION

1ST WORKSHOP ON CLIMATE CHANGE

La Jolla, California (USA) 24-26 February 2025 (*by videoconference*)

DOCUMENT CC-01-02

A PROPOSED FRAMEWORK FOR IATTC'S CLIMATE CHANGE WORKPLAN



Preguntas – Questions?



