

An underwater photograph showing a large school of small, silvery fish swimming in clear blue water. In the foreground and background, there are large, brownish-green seaweed or kelp fronds. The lighting is natural, coming from above, creating a serene and slightly dim atmosphere.

Environmental Health Literacy Software Development for the 1836 Treaty Ceded Fisheries

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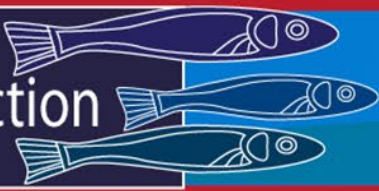
Culture, Subsistence, and Health



Ojibwe Fisherman,
Roland W. Reed, 1908

Me and my little
brother circa 1989





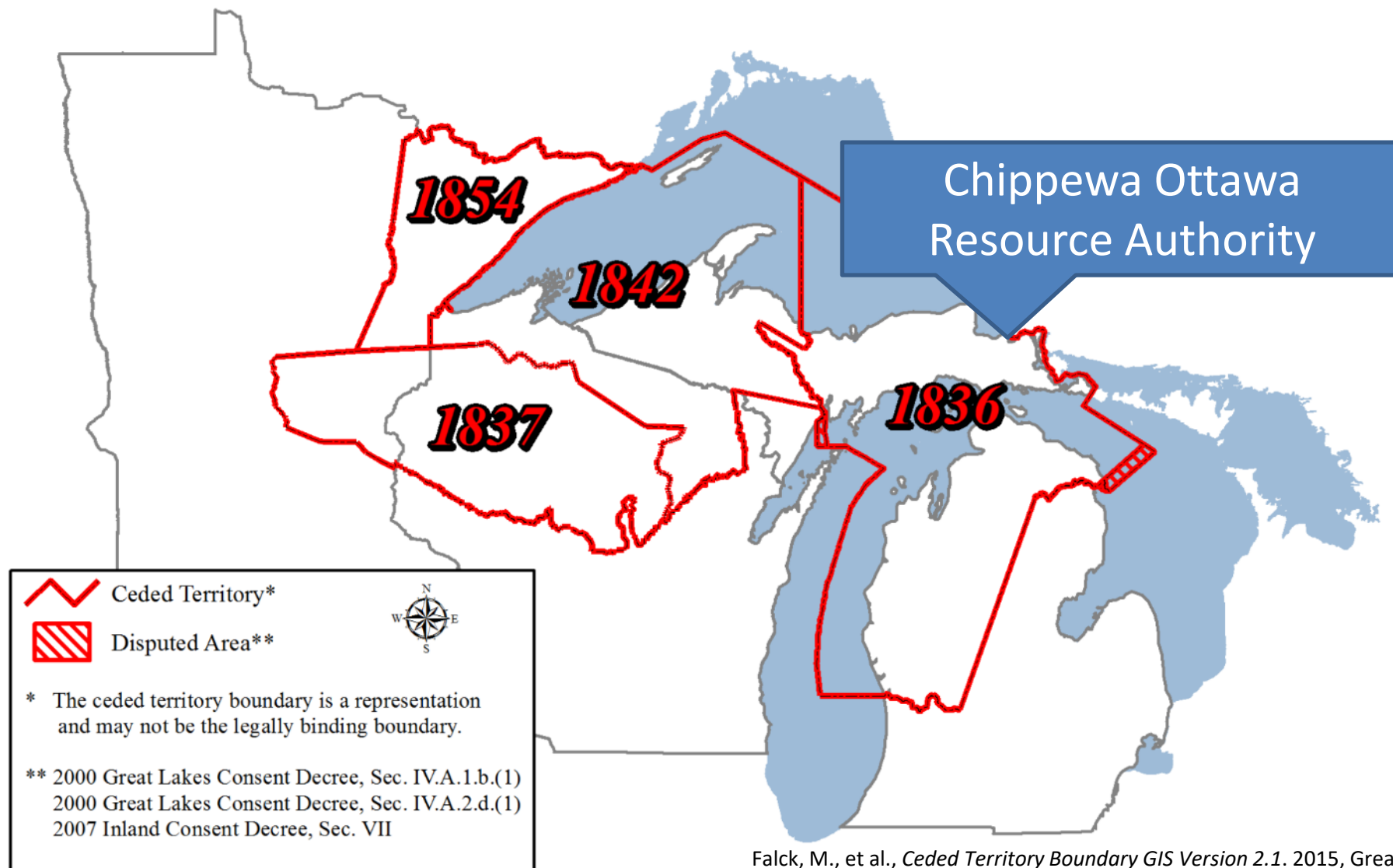
Good Intentions...

"Mercury levels in Chippewa Indians are directly related to how many walleyes they have eaten recently. The higher the number of walleye meals a person has eaten in the past two months, the higher the person's blood mercury is.



The WI “Walleye Wars”





Gigiigoo'inaan 2017-2021

verizon 2:26 PM

Gigiigoo'inaan

Help for making healthy decisions when you and your family eat fish. Enter your information below for recommendations.

Your Weight (lbs)
125

Your Age
35

Your Sex
Male Female

Select a Portion Size
4 oz 6 oz 8 oz

Get Recommendations

verizon 1:51 PM

Fish Recommendations

Walleye
Ogaa

Northern Pike
Gnoozhe

Superior Lake Michigan Lake Huron Other Sources

verizon 1:52 PM

Ogaa

Meals: 1 per month

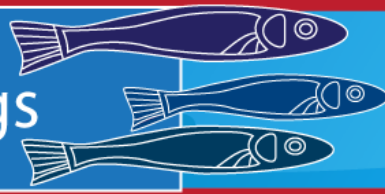
Nutrition Information:
Protein
This fish is high in protein.
Fats
This fish is high in beneficial fatty acids.

Contaminate Information:
Mercury
PCBs

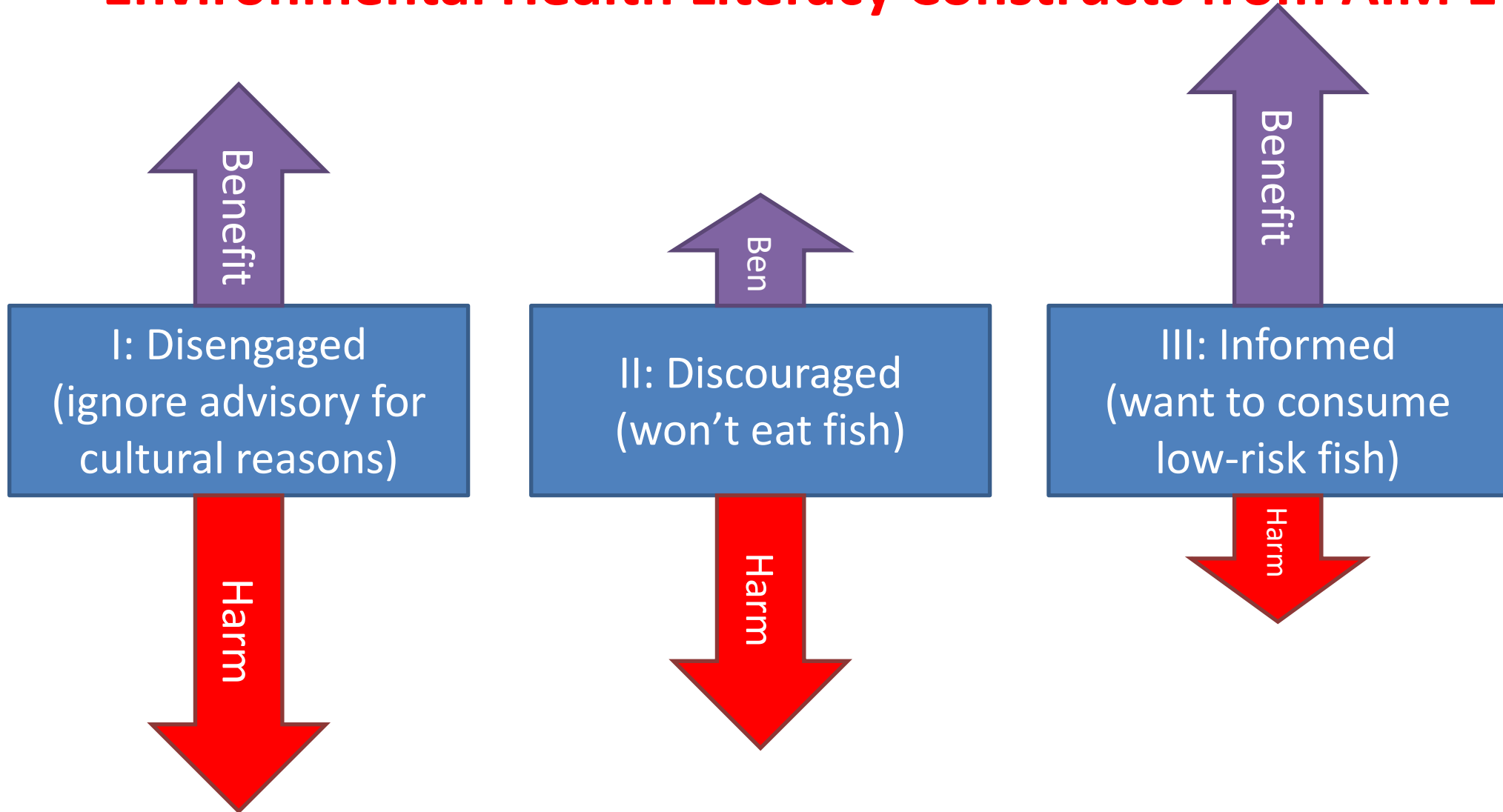


Aim 1 (Dellinger et al 2017,2019)

- **Focus group (talking circles)** stakeholder feedback and pre-post fish consumption questionnaire (N=103)
 - Software well-received and increased confidence
 - Significantly more monthly traditional fish meals (Median: 4 vs 2, $p=0.0005$) and grams selected (Median: 680.39 g vs 453.59 g, $p=0.0007$) pre vs post.
 - Widespread (97%) adherence to conventional advice that minimizes PBT exposure health effects (ATSDR minimum risk levels).



Environmental Health Literacy Constructs from AIM 1



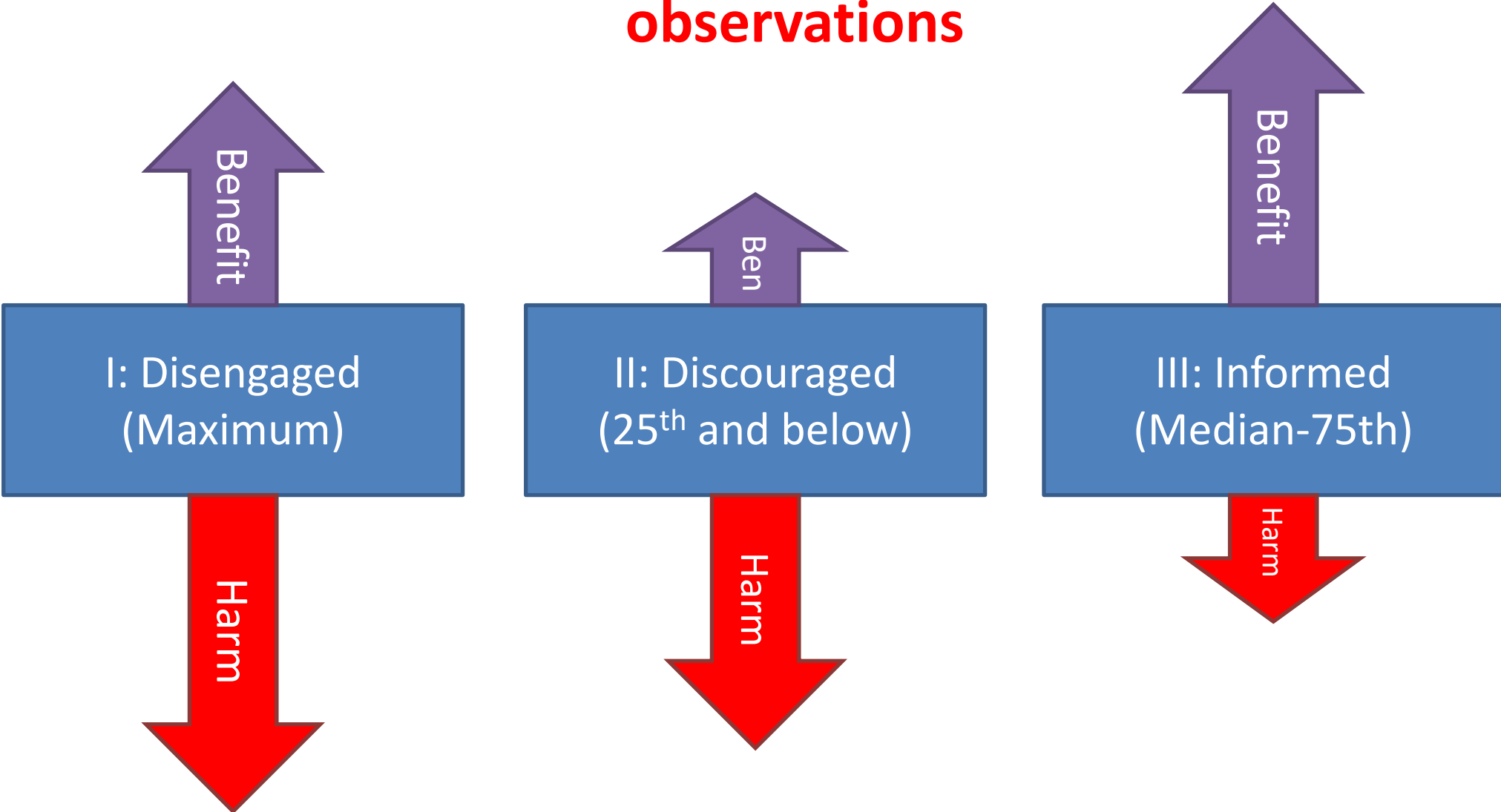
Aim 2 (Dellinger et al. 2020)

- **Linked CORA biomonitoring data to dietary scenarios (Focus groups)**
 - Two risk–benefit models: dioxin-like polychlorinated biphenyls (DL-PCBs), methylmercury (MeHg), and omega-3 polyunsaturated fatty acids (n3-PUFA).
 1. Neurodevelopmental: Visual Recall Memory (VRM), Intelligence Quotient (IQ)
 2. Coronary Heart Disease: (CHD)

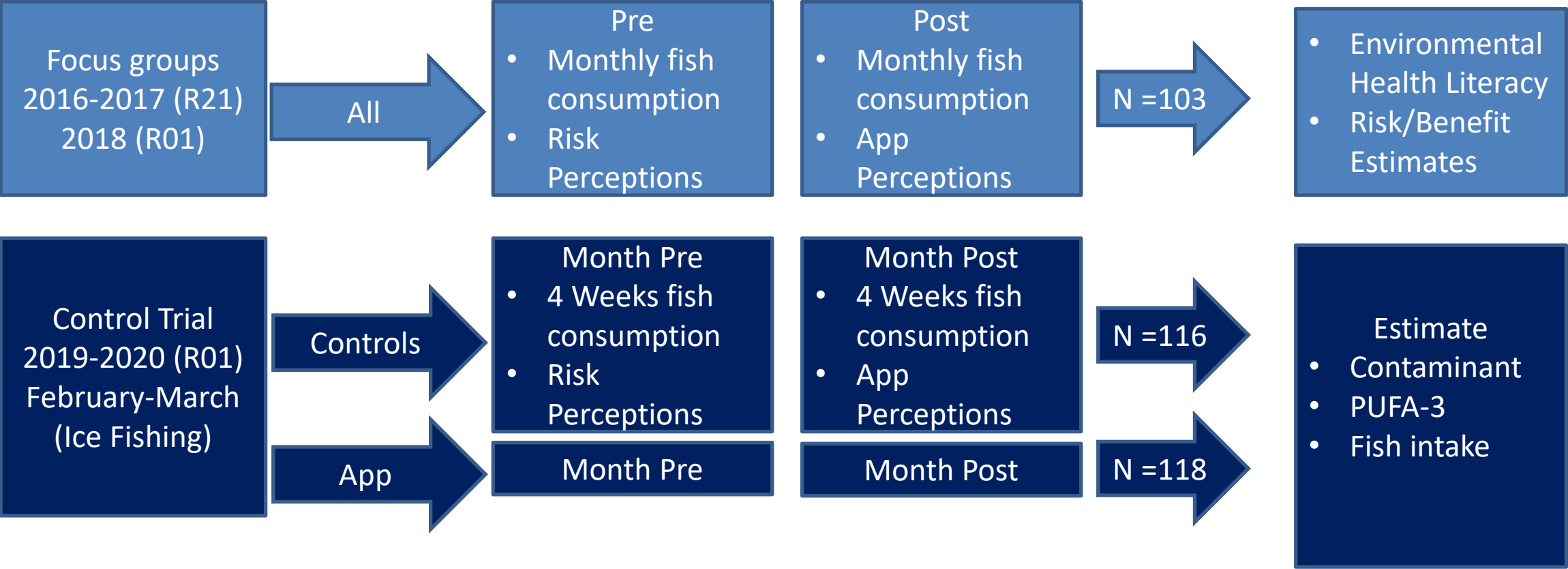
Table 4
 MeHg, DL-PCB, and PUFA-3 intake scenarios based on self-reported monthly meal plans (n = 147 participants) pre and post viewing of fish consumption advice. Risk estimates are based on hair Hg ppm using EPA’s one-compartment model of steady-state daily intake of MeHg at each percentile. TEQ estimates based on 35-year accumulation at the percentile daily intake rate of PCBs. Benefit is estimated from percentile daily PUFA-3 intake (either EPA + DHA or DHA). Risk and benefit parameters for VRM and CHD originally proposed by [Ginsberg et al. \(2009, 2015\)](#) which exclude PCB risks. Negative number indicate increased risk. IQ modeling adapted from [Rheinberger and Hammitt \(2012\)](#).

Scenario		Hair Hg (ppm)	EPA + DHA (mg/week)	CHD Benefit	VRM Net	TEQ (pg/g LW)	IQ net
25th percentile	pre	0.194	709.50	15%	2.40	0.83	1.93
	post	0.263	751.33	16%	2.34	0.93	1.94
50th (median)	pre	0.539	1370.55	28%	4.07	2.84	3.32
	post	0.670	1509.76	28%	4.21	2.63	3.98
75th percentile	pre	0.969	2352.02	26%	5.01	5.48	4.41
	post	1.092	2688.84	23%	4.58	5.54	4.36
100th (max)	pre	7.104	13,327.92	–115%	–16.46	45.35	–5.40
	post	4.662	85,802.09	–59%	–7.92	41.73	–3.94

Environmental Health Literacy Constructs matched with AIM 2 observations



Study Design: Recruit Upper MI Tribal Members



Aim 3 (Dellinger et al. 2022)

Table 2: Self-reported, and projected from focus groups, fish consumption and estimated EPA+DHA intake. The sum of fish consumption (all types) was calculated for Week 1-4 (Pre) and then for Week 5-8 (Post) then applied to biomonitoring contaminant data per species. ANCOVA with covariates (tribal affiliation, age, and sex) was used to model the association between the intervention and fish consumption (trial only). †From Dellinger et al (2020)

Variable	N	Pre-Intervention				N	Post-Intervention				p
		25th	Median	75th	Max		25th	Median	75th	Max	
Fish Consumption (g/month)	240	486.0	911.2	1640.2	6560.9	232	425.2	810.0	1387.1	8079.6	
Control	120	455.6	1093.5	1822.5	6560.9	114	425.2	880.9	1397.2	8079.6	
Intervention	120	486.0	850.5	1397.2	5649.7	118	364.5	789.7	1215.0	7856.9	0.59
Projected†	137	510.3	1077.3	1701.0	9071.9	142	567.0	1360.8	2041.2	6123.5	
Traditional Fish (g/month)	227	60.7	425.2	972.0	6560.9	222	0.0	364.5	911.2	8079.6	
Control	116	151.9	516.4	1093.5	6560.9	112	30.4	425.2	972.0	8079.6	
Intervention	111	0.0	364.5	789.7	4070.2	110	0.0	364.5	729.0	4859.9	0.77
Projected†	137	170.1	453.6	1020.6	8391.5	142	226.8	680.4	1360.8	4535.9	
EPA & DHA (mg/day)	240	65.7	159.0	293.0	2691.9	232	56.4	127.0	242.0	3236.1	
Control	120	62.6	183.8	311.9	2691.9	114	65.6	135.7	249.7	3236.1	
Intervention	120	71.1	128.6	248.9	1765.2	118	44.8	123.7	229.1	1570.6	0.68
Projected†	137	105.5	198.2	366.7	2268.1	142	108.1	230.6	379.4	12257.4	

Aim 3 (Dellinger et al. 2022)

Table 3: Estimated MeHg and PCB intake per kg body weight per day based on self-reported, and projected from focus groups, fish consumption. The sum of fish consumption (all types) was calculated for Week 1-4 (Pre) and then for Week 5-8 (Post) then applied to biomonitoring contaminant data per species. ANCOVA with covariates (tribal affiliation, age, and sex) was used to model the association between the intervention and contaminant intake (trial only).
*exceeds one advisory limit, **exceeds more than one advisory limit, †From Dellinger et al (2020)

Variable	Pre-Intervention					Post-Intervention					p
	N	25th	Median	75th	Max	N	25th	Median	75th	Max	
Mercury (ug/kg/day)	234	0.011	0.03	0.06	0.58**	226	0.006	0.024	0.06	0.37**	0.69
Control	116	0.007	0.03	0.06	0.58**	110	0.005	0.023	0.07	0.37**	
Intervention	118	0.014	0.04	0.06	0.21*	116	0.006	0.026	0.06	0.18*	
Projected†	137	0.02	0.04	0.08	0.58**	142	0.02	0.05	0.09	0.38**	
PCB (ug/kg/day)	234	0	0.001	0	3.24**	226	0	0.001	0.003	1.84**	0.70
Control	116	0	0.001	0.01	3.24**	110	0	0.001	0.004	1.84**	
Intervention	118	0	0.001	0	1.06**	116	0	0.001	0.003	0.1**	
Projected†	137	0	0.01	0.02	0.13**	142	0	0.01	0.02	0.13**	

Aim 3 (Dellinger et al. 2023)

Table 2: Kendall’s tau-b correlation of Anishinaabe self-reported overall *minobimaadiziwin* score and health literacy outcomes of interest at pre (Time 1) and post (Time 2) intervention (controls included).

Health Literacy Data	Time 1 correlation (n)	p-value ^a	Time 2 correlation (n)	p-value ^a
Many fish are safe to eat depending on how much I eat	0.278 (255)	5.9E-8	0.319 (247)	6.0E-12
Confident selecting best fish to eat	0.278 (256)	4.0E-9	0.374 (247)	2.0E-17
Confident selecting best fish for family	0.272 (256)	1.0E-8	0.364 (247)	5.0E-17
EPA & DHA (mg/day)	0.198 (214)	3.7E-5	0.215 (218)	4.1E-5
Fish consumption (g/month)	0.193 (215)	2.3E-4	0.224 (219)	1.3E-5
PCB (µg/kg/day)	0.156 (209)	1.0E-3	0.176 (212)	3.0E-4
MeHg (µg/kg/day)	0.134 (208)	3.1E-3	0.163 (212)	9.9E-4

Note: Fish consumption Omega-3 fatty acids are represented by eicosapentaenoic acid (EPA) + docosahexaenoic acid (DHA). Polychlorinated biphenyl (PCB) and Methylmercury (MeHg) intake were estimated from fish intake at (µg/kg/day). ^a Bonferroni-corrected p-values for 7 comparisons (i.e., p-value multiplied by 7), (null hypothesis: correlations are due to chance).

Aim 3 (Dellinger et al. 2022)

Table 4: User feedback of Gigiigoo’inaan application in the controlled trial (n=74) and focus group data (n=103) summarized from Dellinger et al 2019)

Question	Focus groups N (%)	Trial N (%)
*The app was engaging		
Yes	91 (91.9)	66 (89.2)
No/Neutral	8 (8.1)	8 (11.8)
*The app helped me to identify the best fish to eat		
Yes	96 (97.0)	55 (74.3)
No/Neutral	3 (3.0)	19 (25.7)
*The app is culturally appropriate		
Yes	87 (87.9)	67 (90.1)
No/Neutral	12 (12.1)	7 (9.9)
*The app provides everyday useful information		
Yes	79 (79.8)	61 (82.4)
No/Neutral	20 (20.2)	13 (17.6)
I would eat more fish if I could use this tool		
Yes	60 (58.3)	38 (51.4)
No/Neutral	43 (41.8)	34 (48.6)
I would use this app regularly		
Yes	66 (64.1)	40 (54)
No/Neutral	37 (35.9)	34 (46)
**I would feel more confident about serving fish to my family with this app		
Yes	88 (86.3)	51 (68.9)
No/Neutral	14 (13.7)	23 (31.1)

*n=99, **102

Gigiigoo'inaan 2022-2024

1:13

[Back](#)

Enter your info

Making healthy decisions about fish consumption for you and about your family is important. Let us help you make informed choices by providing personalized recommendations. Simply enter your information below and start your journey towards healthier eating.

[Learn more](#)

Name

Lia

WHY WE ASK

WEIGHT

60

Lbs

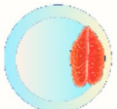
AGE

10

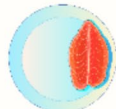
Years

WHY WE ASK

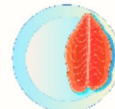
SELECT A PORTION SIZE



4oz



6oz



8oz

ARE YOU PREGNANT (OR PLAN TO BE SOON) ?

☐ NO

☐ YES

SAVE

1:13

Fish

Lakes

HURON

MICHIGAN

SUPERIOR

Fish



Walleye

PROTEIN 19.1g

OMEGA 3/6 2.11g

MEALS / WEEK 1 per month



Northern Pike

PROTEIN 19.3g

OMEGA 3/6 4.438g

MEALS / WEEK 1 per month



Salmon (Wild)

PROTEIN 20.8g

OMEGA 3/6 N/A

MEALS / WEEK 1 per month

Fish

Recipes

Profile

Settings

1:14



Walleye - Ogaa

PROTEIN

OMEGA 3/6

MEALS / MONTH

19.1g

2.11g

1

About

Because walleyes are popular with anglers, fishing for walleyes is regulated by most natural resource agencies. Management may include the use of quotas and length limits to ensure that populations are not overexploited. For example, in Michigan, walleyes shorter than 15 in (38 cm) may not be legally kept. Since walleyes have excellent visual acuity under low illumination levels, they tend to feed more extensively at dawn and dusk, on cloudy or overcast days, and under choppy conditions when light penetration into the water column is disrupted.

The advice herein does not cover local and state advisories on areas of concern or perfluorinated chemicals. This advice covers fish caught within the 1836 Treaty boundaries including some fish purchased at local markets within the same geographical area

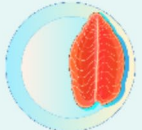
MERCURY

PCB

0.4360 ppm

0.067 ppm

Recipes



WALLEYE AND WILD RICE

COOKING TIME

SERVINGS

30 min

5

[VIEW RECIPE](#)



HONEY FRIED WALLEYE FILLETS

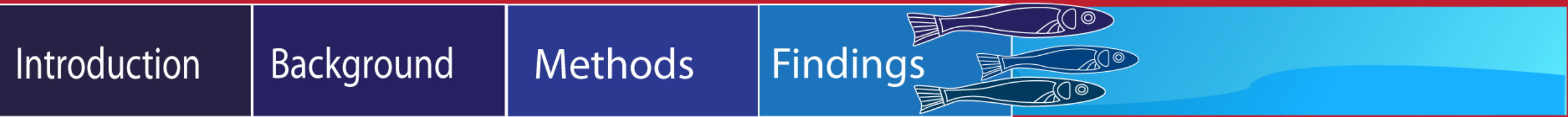
Gigiigoo'inaan 2022-2024

Android: <https://play.google.com/store/apps/details?id=com.shorewoodtech.mealtrackerrfinal>



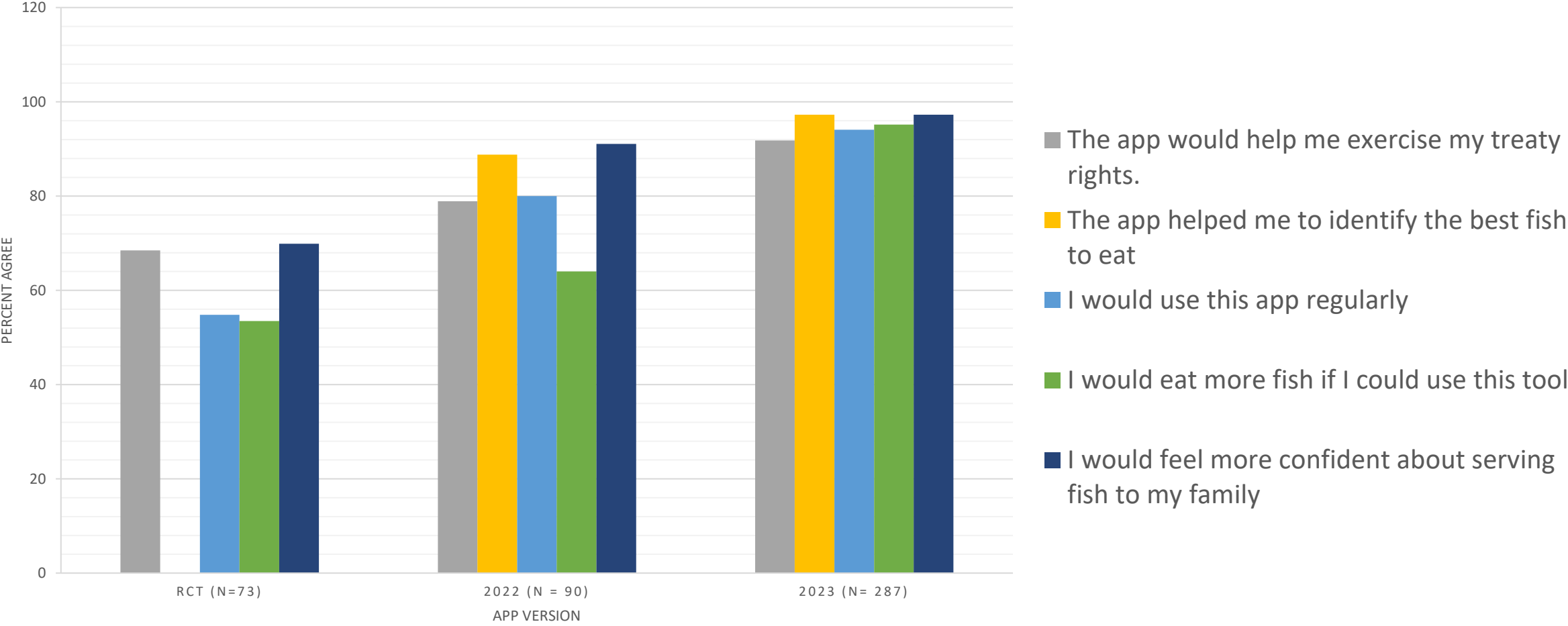
IOS: <https://apps.apple.com/us/app/mcwgiigooapp/id1447081687?ls=1>

Web: <http://mcwfishapp.com/>



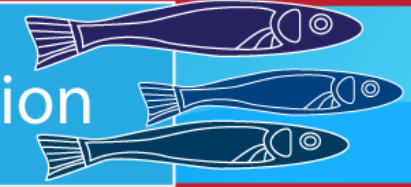
Variable	Total n = 350 (%)	RCT n=73 (%)	2022 n = 90 (%)	2023 n= 287 (%)	Chi-square p
The app was engaging					<.001
Disagree	28 (8.0)	8 (11.0)	17 (19.1)	3 (1.6)	
Agree	320 (92.0)	65 (89.0)	72 (80.9)	183 (98.4)	
Missing	2	0	1	1	
The app is culturally appropriate					0.405
Disagree	27 (7.8)	7 (9.6)	4 (4.5)	16 (8.6)	
Agree	319 (92.2)	66 (90.4)	84 (95.5)	169 (91.4)	
Missing	4	0	2	2	
The app would help me exercise my treaty rights.					<.001
Disagree	57 (16.4)	23 (31.5)	19 (21.1)	15 (8.2)	
Agree	290 (83.6)	50 (68.5)	71 (78.9)	169 (91.8)	
Missing	3	0	0	3	
The app helped me to identify the best fish to eat					0.005
Disagree	15 (5.5)	0 (.)	10 (11.2)	5 (2.7)	
Agree	260 (94.5)	0 (.)	79 (88.8)	181 (97.3)	
Missing	75	73	1	1	
I would use this app regularly					<.001
Disagree	62 (17.8)	33 (45.2)	18 (20.0)	11 (5.9)	
Agree	287 (82.2)	40 (54.8)	72 (80.0)	175 (94.1)	
Missing	1	0	0	1	
I would eat more fish if I could use this tool					<.001
Disagree	74 (21.4)	33 (46.5)	32 (36.0)	9 (4.8)	
Agree	272 (78.6)	38 (53.5)	57 (64.0)	177 (95.2)	
Missing	4	2	1	1	
I would feel more confident about serving fish to my family					<.001
Disagree	35 (10.1)	22 (30.1)	8 (8.9)	5 (2.7)	
Agree	313 (89.9)	51 (69.9)	82 (91.1)	180 (97.3)	
Missing	2	0	0	2	

Preliminary (unpublished) EHL metrics across versions



Summary Points

- Consistent patterns emerge
 - During RCT only maximal intake scenarios exceed *a-priori* advisory limits
 - Stakeholder feedback and preliminary analyses indicate importance of confidence, utility, and cultural appropriateness of Gigiigoo'inaan
 - Updates to software using professional design and ergonomics appear to have improved EHL metrics relative to prototype.



Gigiigoo'inaan encourages healthy fish consumption

