## Interactive Excel Tool for Computing, Assessing, and Using

## **EmP Ws Equations**

## **Tool Philosophy**

Rather than "input data here", and "get Ws equation there", this tool was designed to allow the researcher to participate (by observing or intervening) in the process of setting up the data for equation estimation. In this way, it is hoped that the resulting equation will have less of a "black box" feel, and feel more like a sequence of understandable steps. Excel was chosen as the platform for the tool since it is ubiquitous, and it has graphical and interactive capabilities that most other software packages don't (in combination, at least) have.

### Tool Elements (each element has its own worksheet)

**Raw data:** Simply, a place to organize the length-weight data in a manner that facilitates data quality assurance and analysis.

**Data quality:** The data from a selected sampled population is graphed so that unusual values and other data quality issues can be detected. This sheet is kept hidden unless the user invokes it from the data sheet.

**Collation:** Mean weights for fish in each length class from each study population are recorded. In addition, the number of populations with fish in each length class is noted.

"Number of fish": This sheet, hidden unless invoked by the user from the collation worksheet, tallies the number of fish in each length class from each study population.

**Summarized:** This sheet sets up the data for estimation of quartiles  $(1^{st}, 2^{nd}, and 3^{rd})$  and means of mean weights for each length class.

**EmP-Ws:** On this sheet, the summarized data is organized for estimation of Ws equations (in particular, length classes with insufficient data) are removed from consideration, and the resulting Ws equations are displayed.

Ws graphs: Plots of the resulting equations are done on the log-log and original scales.

**Bootstrap:** A bootstrap study is done to assess precision of the median Ws equations.

**Units:** this sheet allows the user to change measurement units; updated Ws equations and estimates of Ws are then provided.

**Application:** For a chosen study population, scatter plots are drawn of Wr for individual fish, and for means from selected length categories.

## **Instructions for Use:**

### Raw data:

	A	В	C	U	E	F	G	Н		J	K	L	М	N
1	Enter number of	data	set 1	data :	set 2	data	set 3	data	set 4	data	set 5	data	set 6	data s
2	fish nonulations	Length	Weight	Length	Weight	Length	Weight	Length	Weight	Length	Weight	Length	Weight	Length
3		485.14	368.5439	490.2	453.6	279.4	90.7	281.9	90.7	299.7	90.7	622.3	997.9	510.5
4	30	515.62	425.2429	508	499	426.7	317.5	299.7	90.7	302.3	90.72	652.8	1088.62	538.5
5	then	551.18	680.3886	510.5	680.4	434.3	272.2	302.3	90.7	312.4	90.7	655.3	1179.34	563.9
6	Click to act up	553.72	609.5148	525.8	680.4	436.9	317.5	307.3	90.7	312.4	127.01	668	1088.62	566.4
- 7	datasheet.	556.26	595.34	529.7	816.47	469.9	453.6	406.4	226.8	317.5	90.7	673.1	1723.65	594.4
8		558.8	793.7867	535.9	680.4	480.1	499	419.1	317.5	317.5	136.1	678.2	1360.8	596.9
9	Enter your data,	563.88	765.4372	538.5	635	485.1	453.6	424.2	272.2	325.1	136.1	685.8	1451.5	599.4
10	then click below to	571.5	694.5634	542.2	952.54	492.8	499	429.3	272.2	332.7	136.1	685.8	1905.09	599.4
11	record the min. and	571.5	652.0391	546.1	635	492.8	544.3	429.3	272.2	335.3	127.01	688.3	1406.1	602
12	max. lengths.	571.5	708.7381	548.6	816.5	502.9	499	431.8	272.2	350.5	181.4	690.9	1769	607.1
13		571.5	722.9129	551.2	635	505.5	499	434.3	272.2	355.6	181.4	690.9	1451.5	609.6
14	Min & Max	571.5	694.5634	558.8	771.1	505.5	499	436.9	317.5	360.7	226.8	690.9	1632.93	612.1
15	Observed	574.04	652.0391	558.8	907.2	510.5	499	442	317.5	368.3	181.4	708.7	1496.9	612.1
16	minimum length	574.04	737.0877	561.3	589.7	543.6	680.4	447	317.5	373.4	181.4	711.2	1587.57	614.7
17	122	574.04	680.3886	566.4	771.1	571.5	771.1	452.1	317.5	375.9	181.4	711.2	1632.93	622.3
18	Observed	574.04	822.1363	566.4	816.5	612.1	952.5	462.3	362.9	375.9	181.4	721.4	1905.1	624.8
19	maximum length	576.58	708.7381	566.4	816.5	635	1088.6	469.9	453.6	383.5	181.4	721.4	1451.5	632.5
20	1062	576.58	765.4372	566.4	861.8	662.9	1723.7	472.4	408.2	383.5	226.8	723.9	1859.7	635
21		576.58	680.3886	574	771.1	683.3	1723.7	472.4	499	393.7	226.8	723.9	1723.65	635
22	data quality help	576.58	722.9129	574.5	1088.62	685.8	1542.2	477.5	317.5	393.7	226.8	731.5	1723.65	640.1
23	(do this first)	576.58	737.0877	579.1	861.8	690.9	1859.7	480.1	453.6	393.7	226.8	744.2	1905.09	640.1
24		576.58	850.4858	581.7	725.7	693.4	1496.9	485.1	499	393.7	226.8	746.8	1995.8	642.6
25	data quality	576.58	708.7381	584.2	680.4	698.5	1587.6	487.7	408.2	403.9	226.8	749.3	1723.7	647.7
26		576.58	822.1363	586.7	725.7	698.5	1723.7	487.7	499	406.4	226.8	751.8	2177.2	650.2
27	documentation	579.12	694.5634	586.7	771.1	711.2	1814.4	500.4	453.6	408.9	226.8	762	1769.01	652.8
28	пр	579.12	737.0877	589.3	907.2	711.2	1950.4	500.4	453.6	408.9	317.5	762	2177.24	655.3
29	Move to collated	579.12	680.3886	589.3	861.8	713.7	1723.7	502.9	408.2	411.5	226.8	767.1	1814.37	660.4
30	) worksheet.	579.12	765.4372	589.3	907.2	721.4	1723.7	502.9	453.6	411.5	272.2	769.6	1995.8	665.5
14 4	rawdata collat	ed 📈 sumr	marized 📈 E	Emp-Ws 📈	Ns graphs	bootstrap	Units	applicatio	n / 🞾 🖊		∢			▶ 1

- 1. Enter the number of fish populations for which you have length-weight data; the **set up datasheet** button will organize the requisite number of data entry columns.
- 2. Enter your data (hopefully, you can cut & paste it from another file).
- 3. Click the Min & Max button to find the smallest and largest observed lengths in your entire data set. This will be useful in establishing an initial set of length classes to consider.
- 4. Prior to proceeding with the analysis, we recommend you spending some time with the **data quality** sheet so that you can be very confident in the validity of the raw data.

# Data quality:

	A	В	С	D	Е	F	G	Н	1	J		K	L	M		N	0
1			Len	Wgt	log(L)	log(W) j	pop fit (L <mark>)</mark> :	oop fit (O <mark>)</mark>				Not the					
2	Determine		490.2	453.6	2.6904	2.65667	2.630171	426.7479			'	weight	versus L	engtn			
3	Return to		508	499	2.7059	2.6981	2.684321	483.4155		6000						_	
4	data shee	L.	510.5	680.4	2.708	2.83276	2.691773	491.7829									
5			525.8	680.4	2.7208	2.83276	2.736605	545.2613		5000					••	7	
6	Number of po	pulations	529.7	816.47	2.724	2.91194	2.747824	559.5303		4000					14.1	. ·	
- 7		30	535.9	680.4	2.7291	2.83276	2.76549	582.7603		4000					19935	••	
8			538.5	635	2.7312	2.80277	2.772838	592.7037		3000					20 <mark>(3</mark> °		
9	Enter the num	ber for the	542.2	952.54	2.7342	2.97888	2.783233	607.062					2	80 S	5 H T		
10	population ye	ou wish to	546.1	635	2.7373	2.80277	2.794114	622.4635		2000			1000	1999 - Carlos	•	_	
11	study, then		548.6	816.5	2.7393	2.91196	2.801048	632.4817				÷	22				
12		2	551.2	635	2.7413	2.80277	2.808226	643.0222		1000		and the second second				_	
13	<b>CH</b> 1 4		558.8	771.1	2.7473	2.88711	2.829015	674.5518									
14	Click to	Click to collect ? data	558.8	907.2	2.7473	2.9577	2.829015	674.5518		0 +						_	
15	collect data		561.3	589.7	2.7492	2.77063	2.835792	685.1603		400	500	600	700	800	900	1000	
16	data	566.4	771.1	2.7531	2.88711	2.849524	707.17									<b>آ</b>	
17	Regression	n Summary	566.4	816.5	2.7531	2.91196	2.849524	707.17				Log(W)	versus	Log(L)			
18	(log-log	j scale) 👘	566.4	816.5	2.7531	2.91196	2.849524	707.17		4							
19	Intercept	-6.089354	566.4	861.8	2.7531	2.93541	2.849524	707.17									
20	Slope	3.2675615	574	771.1	2.7589	2.88711	2.869759	740.899									
21	R <sup>2</sup>	90.52%	574.5	1088.62	2.7593	3.03688	2.871081	743.1575		2.5						sti.	
22	no. of fish	1160	579.1	861.8	2.7628	2.93541	2.883188	764.1668		3.0					العبر الأ		
23			581.7	725.7	2.7647	2.86076	2.889989	776.2274						1. 15	18 ° 1		
24			584.2	680.4	2.7666	2.83276	2.8965	787.9517					1.5				
25			586.7	725.7	2.7684	2.86076	2.902982	799.8019		3			19 A.	•		+	
26			586.7	771.1	2.7684	2.88711	2.902982	799.8019				اطنين ا	F*				
27			589.3	907.2	2.7703	2.9577	2.909695	812.2605									
28			589.3	861.8	2.7703	2.93541	2.909695	812.2605		2.5							
29			589.3	907.2	2.7703	2.9577	2.909695	812.2605		2.0 +		,					
30			591.8	907.2	2.7722	2.9577	2.916122	824.37		2.6	2.1	/	2.8	2		3	
14 4	🕨 🕨 🛛 rawda	ta 🔒 data qu	ality / col	lated 📈 s	ummarize	ed 📈 Emp	-Ws 📈 Ws	graphs 📈 b	ootstr	ap 📈 Units	s 🖉 applic	ation 🏑	ا ا 💭		Ш		

- 1. Enter the number (numbers are those assigned on the raw data sheet) for the population you want to look at.
- 2. Click to collect the data.
- 3. A numerical summary of the log(W)-log(L) regression for that population is given in the table on the left of the screen.
- 4. The data values are plotted in scatter plots with the log-log regression from the entire data set drawn on them to provide a reference point. Example: If the majority of the points for one population fall below (or above) the population regression line, that might be due to length having been measured by a different protocol for that population. At any rate, you can detect such things as well as individual gross data entry errors using this sheet.

# **Collation:**

	A	В	С	D	E	F	G	Н		J	К	L	М	N	0
1				Le	ength Bins	5	No. of	Summa	ary of dat	a for each	o populati	on, in eac	h class		
2	Minimum	Length		Chart	End	Mid	popn's	Set 1	Set 2	Set 3	Set 4	Set 5	Set 6	Set 7	Set 8
3	Observed:	122		Start	Enu	MIU	w. data	Mean W	Mean W	Mean W	Mean W	Mean W	Mean W	Mean W	Mean W
4	Choice:	120		120	130	125	1								
5	Maximum	Length	Helpon	130	140	135	0								
6	Observed:	1062	Choices	140	150	145	0								
- 7	Choice:	1062	CHOICES	150	160	155	0								
8				160	170	165	0								
9	Choose bi	n width;		170	180	175	0								
10	typical is 1	10 (mm)		180	190	185	1								
11		10		190	200	195	0								
12	Once bins	are set		200	210	205	1								
13	up, click to	up, click to collate		210	220	215	2								
14	colla	collate Data		220	230	225	0								
15			D ata	230	240	235	1								
16		Qu	ality H int	240	250	245	2								
17				250	260	255	2								
18	Number of po	pulations		260	270	265	4								
19		30		270	280	275	2			90.7					
20	Number	of bins		280	290	285	4				90.7				
21		95		290	300	295	4				90.7	90.7			
22				300	310	305	5				90.7	90.72			
23	Move to	o the		310	320	315	4					111.1275			
24	summa	rized"		320	330	325	4					136.1			
25	sheet, or cl	neck the		330	340	335	7					131.555			
26	"number o	of fish"		340	350	345	4								
27	summary			350	360	355	6					181.4			
28	Number of Fish		360	370	365	5					204.1				
29	Number	DIFISH		370	380	375	7					181.4			
30	h ht mundet			380	390	385	8	/11-3	and the time			204.1			
14 4	rawdat		eu / summ	arized 🔬 En	np-ws 🖉 W	s graphs 🔬	Dootstrap	Units	application					0	

- 1. Enter a value for the lower limit of the lowest length class, and a choice for the longest length that you want to consider (here, with 1062 mm selected, the largest length class is from 1060 mm to 1070 mm). Also indicate the bin width (10 mm is usual for most studies; some researchers working with juvenile fish have used 5 mm).
- 2. **Click** the **collate** button. The mean weight for fish in each length class, from each population, will be recorded.
- 3. Note for this illustration that the length classes for lengths less than 250 mm are represented by very few populations. We'll return to this when we discuss the bootstrapping sheet.
- 4. To take the sample size examination, a little deeper, **click** the **Number of fish** button.

# "Number of fish":

	A	В	С	D	E	F	G	Н	1	J	K	L	M	N	
1	Column B con	tains the total	Le	ength Bins	;	Recorde	d here are	e the num	bers of fis	sh in each	class for	each pop	oulation.		
2	number of fish	in each class,	Start	End	Mid	Set 1	Set 2	Set 3	Set 4	Set 5	Set 6	Set 7	Set 8	Set 9	Se
3	summed over a	all populations.	Start	LIIU	MIU	Numfish	Numfish	Numfish	Numfish	Numfish	Numfish	Numfish	Numfish	Numfish	Nur
4		1	120	130	125	0	0	0	0	0	0	0	0	0	
5	back-	0	130	140	135	0	0	0	0	0	0	0	0	0	
6	ground	0	140	150	145	0	0	0	0	0	0	0	0	0	
7		0	150	160	155	0	0	0	0	0	0	0	0	0	
8	Return	0	160	170	165	0	0	0	0	0	0	0	0	0	
9		0	170	180	175	0	0	0	0	0	0	0	0	0	
10		1	180	190	185	0	0	0	0	0	0	0	0	0	
11		0	190	200	195	0	0	0	0	0	0	0	0	0	
12		1	200	210	205	0	0	0	0	0	0	0	0	0	
13		2	210	220	215	0	0	0	0	0	0	0	0	0	
14		0	220	230	225	0	0	0	0	0	0	0	0	0	
15		1	230	240	235	0	0	0	0	0	0	0	0	0	
16		6	240	250	245	0	0	0	0	0	0	0	0	0	
17		3	250	260	255	0	0	0	0	0	0	0	0	0	
18		6	260	270	265	0	0	0	0	0	0	0	0	0	
19		3	270	280	275	0	0	1	0	0	0	0	0	0	
20		4	280	290	285	0	0	0	1	0	0	0	0	0	
21		5	290	300	295	0	0	0	1	1	0	0	0	0	
22		7	300	310	305	0	0	0	2	1	0	0	0	0	
23		8	310	320	315	0	0	0	0	4	0	0	0	0	
24		7	320	330	325	0	0	0	0	1	0	0	0	0	
25		9	330	340	335	0	0	0	0	2	0	0	0	0	
26		8	340	350	345	0	0	0	0	0	0	0	0	0	
27		11	350	360	355	0	0	0	0	2	0	0	0	0	
28		22	360	370	365	0	0	0	0	2	0	0	0	0	
29		18	370	380	375	0	0	0	0	3	0	0	0	0	
30		20	380	390	385	0	0	0	0	2	0	0	0	0	
14 4	I rawdata	🔍 collated 📜	numfish 🦯 🤅	summarized	CEmp-W	s 🖉 Ws gra	ohs 🖌 boot	tstrap 📈 UI	nits 🖉 appl	ication 🏑 📍					
Read	dv 📍												100% 🕞 –		

This sheet, hidden unless invoked by the user from the collation worksheet, tallies the number of fish in each length class from each study population. On the left of the sheet is the total number of fish in each length class, summed over all the study populations. Note, in this illustration, the paucity of data for the smaller length classes.

#### Summarized:

	A1	- (	Jx												*
	A	В	С	D	E	F	G	Н	1	J	K	L	M	N	0
1															
2															
3			Bin	No. of		Stat	istic								=
4			Center	datums	Q1	Median	Q3	mean							
5	or Li		125	1		7.2		7.2	7.2						
6	Click to (	collate	135	0											
-7	eummary	ctatictice	145	0											
8	for each	length	155	0											
9	class.and	d do the	165	0											
10	Ws regre	ssions	175	0											_
11	, i i i i i i i i i i i i i i i i i i i		185	1		20.6		20.6	20.6						
12			195	0											
13			205	1		22.7		22.7	22.7						
14			215	2		37.95		37.95	30.5	45.4					
15			225	0											
16			235	1		40.8		40.8	40.8	4455					
17			245	2		44.3		44.3	44.05	44.55					
18			255	2	50.05010	53.3	05 1105	53.3	49.9	56.7	01.4				
19			265	4	53.05313	50.7	65.1125	59.2625	47.65	60	61.4	68			
20			275	4	CO 075	73.75	00.7	73.75	0.00	90.7	00.7	00.7			
21			205	4	00.075	00.35	30.7 00.1107E	73.05	00	70	90.7	90.7			
22			200	4	30.7 00.0010E	30.7	11070	31.773 102.404	00.7	30.7	30.7	100	150		
24			315	1	9476975	100	106 2592	100.404	90 7	100	100	111 1275	100		
25			325	4	90 30625	93 41667	118 6146	103 2333	90.7	90.7	9613333	1361			
26			335	7	103 75	125	135 2478	124 665	100	100	120	125	131 555	136.1	160
27			345	4	136 7563	142 1333	176 6667	155 0917	1361	137.6	146 6667	200	101.000	100.1	
28			355	6	135,5938	147.6	182.5625	156,7833	128	1361	145.2	150	181.4	200	
29			365	5	139.2188	152,4667	190.4777	163.6705	137.5	140	152,4667	184.2857	204.1	200	
30			375	7	175.1884	181.4	188.9563	181.698	165	174.2857	179.1	181.4	181.4	190.7	200 🗸
14 4	► ►I rawd	ata / collate	ed summ	arized / E	mp-Ws / V	Vs graphs	bootstrap	/ Units /	application	/					
Read	v 🎦												100%	0	

- 1. Click to have the data re-organized for computation of summary statistics.
- 2. This sheet sets up the data for estimation of quartiles (1<sup>st</sup>, 2<sup>nd</sup>, and 3<sup>rd</sup>) and means of mean weights for each length class. The available means for each length class are sorted, and laid out in the relevant row (at this point, connection to specific study populations is not retained).
- 3. The mean and median are computed for all length classes with at least one mean, and the 1<sup>st</sup> and 3<sup>rd</sup> quartiles are computed for length classes with three or more means.
- 4. You are likely tired, by now, of our noting the paucity of data for shorter length classes, so we won't bother doing that again.
- 5. Turn to the **EmP-Ws** sheet for results.

#### **EmP-Ws:**

	A	В	С	D	Е	F	G	Н	I	J	K	L	М	N	0
1	Number of effect	tive bins				Number of effect	tive bins								
2		73					85				Aquada	atia WC			
3											Aquatio	nio tho	Current	Clickto	
- 4	Bin Center	No. datums	Q1	Q3		<b>Bin Center</b>	No. datums	Median	Mean		default (	n is uie Shonno it	Ws Type	chenge W	
5	265	4	53.05313	65.1125		125	1	7.2	7.2		if you	manye n wiek	quadratic	Type	°
6	285	4	68.875	90.7		185	1	20.6	20.6		ii you	wisn.		1 1 100	
7	295	4	90.7	93.11875		205	1	22.7	22.7						
8	305	5	89.23125	115.625		215	2	37.95	37.95		Log-Log S	Standard	Weight	SE of	
9	315	4	94.76875	106.2592		235	1	40.8	40.8		Regressi	on equati	on terms	Curvature	
10	325	4	90.30625	118.6146		245	2	44.3	44.3		Intercept	linear	quadratic	Term	
11	335	7	103.75	135.2478		255	2	53.3	53.3	Q1	-1.415313	-0.37765	0.6951952	0.1209333	
12	345	4	136.7563	176.6667		265	4	60.7	59.2625	Median	-1.480167	-0.29792	0.6783162	1.0653692	
13	355	6	135.5938	182.5625		275	2	73.75	73.75	Q3	0.8666925	-1.93954	0.9686845	0.0960914	_
14	365	5	139.2188	190.4777		285	4	80.35	79.85	Mean	-1.342968	-0.36941	0.6866696	1.0556191	_
15	375	7	175.1884	188.9563		295	4	90.7	91.775						
16	385	8	182.2458	202.3063		305	5	90.72	103.484		Do B	o o ts tra p	Study		
17	395	7	200	226.8		315	4	100	100.4569		0	f Precisio	on l		
18	405	12	222.3	243.4375		325	4	93.41667	103.2333						
19	415	8	228.1125	290.2328		335	7	125	124.665						
20	425	11	254.7732	298.125		345	4	142.1333	155.0917			E xa mine N	Ns		
21	435	15	273.2438	300		355	6	147.6	156.7833			Graphica	lly		
22	445	12	293.9788	310.5479		365	5	152.4667	163.6705			1			
23	455	10	310.8516	342.6394		375	7	181.4	181.698						
24	465	14	344.4539	410.8594		385	8	189.0917	191.5771		A	pply Wst	to a		
25	475	15	361.0516	400		395	7	202	216.0347		fi	sh popula	tion		
26	485	19	387.7188	448.5		405	12	231.35	234.0961			1			
27	495	17	406.5127	460.1042		415	8	236.975	260.9615						
28	505	18	434.1125	499		425	11	279.7333	276.231		<u>c</u>	hange un	its of		
29	515	23	481.7188	537.1594		435	15	294.8	290.7939		m	easureme	ent (if		
30	525	18	500	570.8748		445	12	300	309.9172			you wis	h)		
H 4	🕨 🕨 🔤 rawda	ita 🧹 collateo	d 📈 summa	rized 🚶 Em	p-W	s 🖉 Ws graphs	🖌 bootstra	p 🖉 Units ,	applicatio	n / 🞾 /			ш		▶ 1
0															6

- 1. For sake of keeping neatly organized, one more data summary is done, namely to organize the relevant data (excluding length classes with too little or no data) for each of the target summary statistics.
- 2. Once done, the regression equations are computed for each summary statistic (all three quartiles and the mean). The choice of using a linear regression or a quadratic is given (one of us, at least, is inclined to always use a quadratic, but that choice properly belongs to the researcher). As an aid to assessing the utility of a quadratic, the standard error of the quadratic term is displayed.
- 3. The yellow buttons that take you to other worksheets are self-explanatory.

# Ws graphs:



Plots of the resulting equations are done on the log-log and original scales. Michael and Kate: I'm not sure if this sheet is all that useful, so I'm not going to elaborate on this one just now...

## **Bootstrap:**

💽 b:	s trial c	lean3 [Com	patibility M	lode] - Mie	crosoft Ex	cel										-	σx	
	А	В	С	D	E	F	G	Н	I.	J	К	L	M	N	0	P		
1																		
2			Wh	at's this				Choose a			Summary						-	
3		Emp.We	all	about?				length		Length	172						minu	
4		Sheet						172		mean	18.1567						plus	
5	_	0	De		your leng	jth range				SE	0.85881							
6			boots	trap	120	1062		2	<u> </u>	CV	4.73%							
7			stu	dy						MoE	1.68326							
8			_	-				bootstrap		RMoE	9.27%							
9								estimates			Relative	MoE of Med	ian EmP.Ws	Estimates			step	
10	run	intercept	linear	quad				at length		10.00			len					
11	1	1.294327	-2.26077	1.024658				22.96806051		18.00								
12	2	0.884308	-2.00206	0.984315				21.27399921		14.00	16.00%							
13	3	0.352382	-1.61514	0.914714				20.5618006		12.00	12.00%							
14	4	0.01123	-1.37468	0.872615				19.90963945		10.00	%							
15	5	0.549379	-1.73043	0.93116				21.60285788		8.00	%							
10	5	0.224639	-1.53387	0.901561				20.01035419		6.00	» <del>  \</del>							
17	<u></u>	0.408214	-1.66697	0.926783				20.36444377		4.00	%							
10	8	-0.39403	-1.09758	0.025600				10.90210021		2.00	% <b></b>							
19	9	-0.65210	-0.90500	0.790020				10.00110203		0.00	% +							
20	11	-0.99070	0.0000	0.023307				17 0EC2777E			100	600	11	00	1000			
22	12	-0.33371	-1.20570	0.740703				19.47602742										
22	12	-0.27747	-0.94999	0.040330				17 92/61296			Approxima	te 95% bou	nds for Medi	an EmP-Ws	-			
2.1	14	-0.94601	-0.04222	0.70203				17.02401000		8000 -	Approxima				ŀ			
25	15	-1.07203	-0.61691	0.77031				17.82309095		7000								
26	16	-0.4966	-1.02926	0.814088				18 66113084		0000								
27	17	-0.75671	-0.84593	0.781816				18 1707632		0000								
28	18	-0.83026	-0.79225	0.771831				18 02691715		5000				1				
29	19	-1.57365	-0.23791	0.669074				17.3078143		4000								
30	20	-1.08186	-0.60389	0.736579				17.75168664		3000 -					— I			
31	21	-1.03287	-0.64057	0.743395				17.79478753		2000 -								
32	22	-1.38428	-0.37319	0.692985				17.56658131		1000								
33	23	-1.49151	-0.29297	0.678088				17.47186762										
34	24	-1.58041	-0.22519	0.665286				17.41807918			200	500	700 000	1100	1200			
35	25	-1.37963	-0.37221	0.691953				17.63456268		100	, 300	500	700 900	/ 1100	1300			
36	26	-1.45275	-0.31495	0.680832				17.60681764		L								
37	27	-1.43637	-0.3185	0.680142				17.81116457										
37	21	-1.43637	-0.3185	0.000142				17.01116457										

#### Notes to M & K:

- 1. The bootstrapping currently does only 100 replicates. Formerly, that took many many hours; now it takes only a few minutes. It would be easy to give the user the option of how many to do. Your thoughts?
- 2. The graph showing the approximate 95% bounds for the median Emp-Ws is not very useful I think (by necessity of scale, the three lines (median Ws, and upper and lower bounds) are going to be hard to distinguish. Kill it?
- 3. I'm not sure whether the ability to get a numerical summary of the bootstrap results for individual lengths adds much utility. The relevant information is visible on the graph. If you think it is useful (or at least, interesting), we can keep it. Otherwise, its removal would make the page cleaner.
- 1. Each bootstrap replicate consists of the following steps:
  - a. Randomly select, with replacement, *n* integers from 1 to *n*, where *n* is the number of populations being used to form the Ws equation. This represents the act of

randomly selecting n populations from the conceptual collection of all such populations.

- b. For each selected population, randomly select, with replacement  $n_i$  pairs of lengths and weights, where  $n_i$  is the number of fish in the  $i^{th}$  sampled population. This represents the act of randomly sampling from that particular population.
- c. Collate, organize, and compute the EmP-median Ws equation for that replicate.
- 2. Repeat Step 1 a large number of times.
- 3. For each length class, compute a relative margin of error (RMoE) as follows. Let  $SE_i = SD_i / \sqrt{n_i}$  be the standard error of the mean of the estimated Ws for that length class. Then  $2 \times SE_i$  is the approximate margin of error (MoE) for a classical 95% confidence interval (the MoE is the plus/minus part of the C.I. calculation. Then MoE divided by the mean for that length class reports the precision of the mean on a relative scale.
- 4. In the illustration, notice that the RMoE is quite large for the smaller length classes, due to the paucity of data therein. This observation might impel the researcher to re-do the Ws computations using a larger lower limit.

# Units:

	А	В	С	D	E	F	G	Н		J	K	L	М	N	0
1															
2				This is a u	nits-trans	lation tool	l, working	y with mm an	d inches						
3				for length,	and gram	is and poi	unds for v	veight.							
4															
5							ا م ا	-log We Be	arossion o	austion to	arme				
6							LUg	Log Horie	gressione	quation a	511115				
7		w	eiaht uni	ite											
8			cigin din				Old Unit	s			New Unit	S			
9						Intercept	linear	quadratic		Intercept	linear	quadratic			
10		Old		New		-1.41531	-0.37765	0.69519521	Q1	-0.573833	1.575623	0.69519521			
11		grams	correction	grams		-1.48017	-0.29792	0.67831625	Median	-0.559991	1.607929	0.67831625			
12			1			0.866693	-1.93954	0.9686845	Q3	0.053716	0.782143	0.9686845			
13		Select		Select		-1.34297	-0.36941	0.68666962	Mean	-0.506751	1.5599	0.68666962			
14															
15															
16		l e	enath un	its											
17			ingar an												
18									Return to						
19		Old		New					Emp-Ws						
20		mm	correction	inches					sheet						
21			0.03937												
22		Select		Select											
23							Old Unit	S			New Unit	s			
24															
25			Enter a singl	le length (in		Q1	796.403			Q1	796.403				
26			original units	) for Ws		Median	846.270			Median	846.270				
27			calculations	in original	600	Q3	901.122		23.622	Q3	901.122				
28			and new unit	IS.	mm	Mean	852.204		inches	Mean	852.204				
29							grams				grams				
30										1.4					
	<b>F</b> FI	rawdata	🖉 collated 📈	summarized	/ Emp-Ws	🖉 Ws graph	ns 🖉 boots	strap 📜 Units	application						
Ready	/												100% 😑		

On occasion, one might wish to present standard weight in units other than those used to generate the Ws in the first place. We assume here that researchers are likely to use for length and weight millimeters and grams, or inches and pounds. This sheet lets you choose which of those units you want to consider.

# **Application:**

		1110	•	C	<i>J.</i> *													•
		A	В	С	D	E	F	G	Н		J	K	L	М	N	0	Р	-
1				Len	Wgt												log(L)	lc 🔔
2		Return	to data	279.4	90.7				Wr Evalu	ation							2.4462	1
3		sh	eet	426.7	317.5		E	nter bound	aries for sto	ck length a	categories						2.6301	2
4				434.3	272.2			stock	quality	memorable	Preferred	Trophy	?				2.6378	2
5	- h	nsert L	enath-	436.9	317.5	Wr		250	380	510	640	810	_				2.6404	2
6	W	eiaht d	ata into	469.9	453.6	Summaries	BS	S-Q	Q-M	M-P	P-T	T		The summ	naries on this	1	2.672	2
7	со	lumns (	C and D	480.1	499	num. of fish	0	1	11	5	37	15		sheet use	the		2.6813	
8				485.1	453.6	minimum			95.1744558	102.168	81.03348	81.96207					2.6858	2
9		Summ	nary	492.8	499	median		125.720531	110.160971	105.4605	110.5063	102.2693		me	edian		2.6927	
10	n	o. of fish	69	492.8	544.3	maximum			125.435434	112.6536	143.5912	126.279		as a choir	e for a		2.6927	2
11	Mir	n Length	279.4	502.9	499	mean		125.720531	112.611013	106.5537	111.9966	105.3949		baseline.			2.7015	
12	Ma	x Length	891.5	505.5	499	st. dev			9.51114239	3.922923	14.08992	13.69249					2.7037	
13				505.5	499												2.7037	
14	Se	elect the	baseline	510.5	499							Me	an Wr for	stock cla	sses		2.708	
15	parameter you wish l use		ou wish to	543.6	680.4												2.7353	2
16	use		571.5	771.1												2.757	2	
17	7 median				952.5		1	1	i.								2.7868	2
18		meu		635	1088.6	i	In	ndividual V	alues			W/r h	vlen	oth C			2.8028	3
19				662.9	1723.7	150 -							y Len	5 <sup>11</sup> C	Lusses		2.8214	3
20				683.3	1723.7	140			• •			130					2.8346	3
21			· ·	685.8	1542.2	130							•				2.8362	3
22				690.9	1859.7	100	•	<b>2</b>	- <b>1</b> - 1	• •		120					2.8394	3
23	S	umma riz	zedata	693.4	1496.9	120 T	•			•	<u>₽</u>	110	• •		•	◆ Wr	2.841	3
24				698.5	1587.6	110 -	*	- <u> </u>					•	• •			2.8442	3
25				698.5	1723.7	100			+10		2	100				• Q3	2.8442	3
26				711.2	1814.4	90 -					1	00	• •	• •	•	• 02	2.852	3
27				711.2	1950.4	80 -			•	•		50					2.852	3
28		low to		713.7	1723.7	70 -						80				• Q1	2.8535	3
29	- 1		, use	721.4	1723.7	60 -			1	-	_	0 1	2 3	4 5	6 7		2.8582	3
30	-	this s	heet	723.9	1814.4	25	0 45	50 6	50 1	350		0 1	. 2 3				2.8597	3
31	_			723.9	1905.1						H		Ax	is Title			2.8597	3
32				/26.4	2177.2												2.8612	_
33				729	2177.2												2.8627	
34			data (	731.5	2404	ad (Ener 14)	a / 14/a c	he /he-t		a and b	ation /*						2.8642	3
14 4		raw	uaca 🔬 co	naced 🖉 s	ummariz	eu 🔬 Emp-W	s 🖉 vvs grap	ms / boot	suap 🔬 Unit	s_applic	ation / *	d l				_		
D	also de														010/	( )	data data data data data data data data	- ( I ).

- 1. Enter length-weight data for a population whose relative weight you are interested in studying.
- 2. Click the summarize data button.
- 3. Scatter plots are drawn of Wr for individual fish, and for means from selected length categories. For the illustrated "test" population, the **Individual values** graph shows that most of the fish are above the median; on average, the means in each length category are near or above the third quartile.