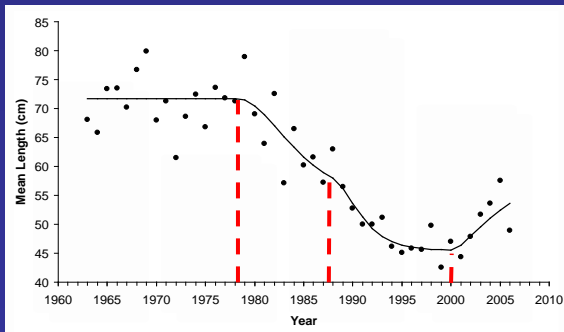


“Developing smart scales and data solutions for small scale fisheries”

Creative approaches and emerging tools for stock assessments

EDF Workshop Series 2021

September 15, 2021



Todd Gedamke
(MER Consultants
Todd@merconsultants.org)

Bill Harford
(Nature Analytics
bill@natureanalytics.ca)

**You are not
alone!!**



**Data Poor
Assessments are
Global Challenge**

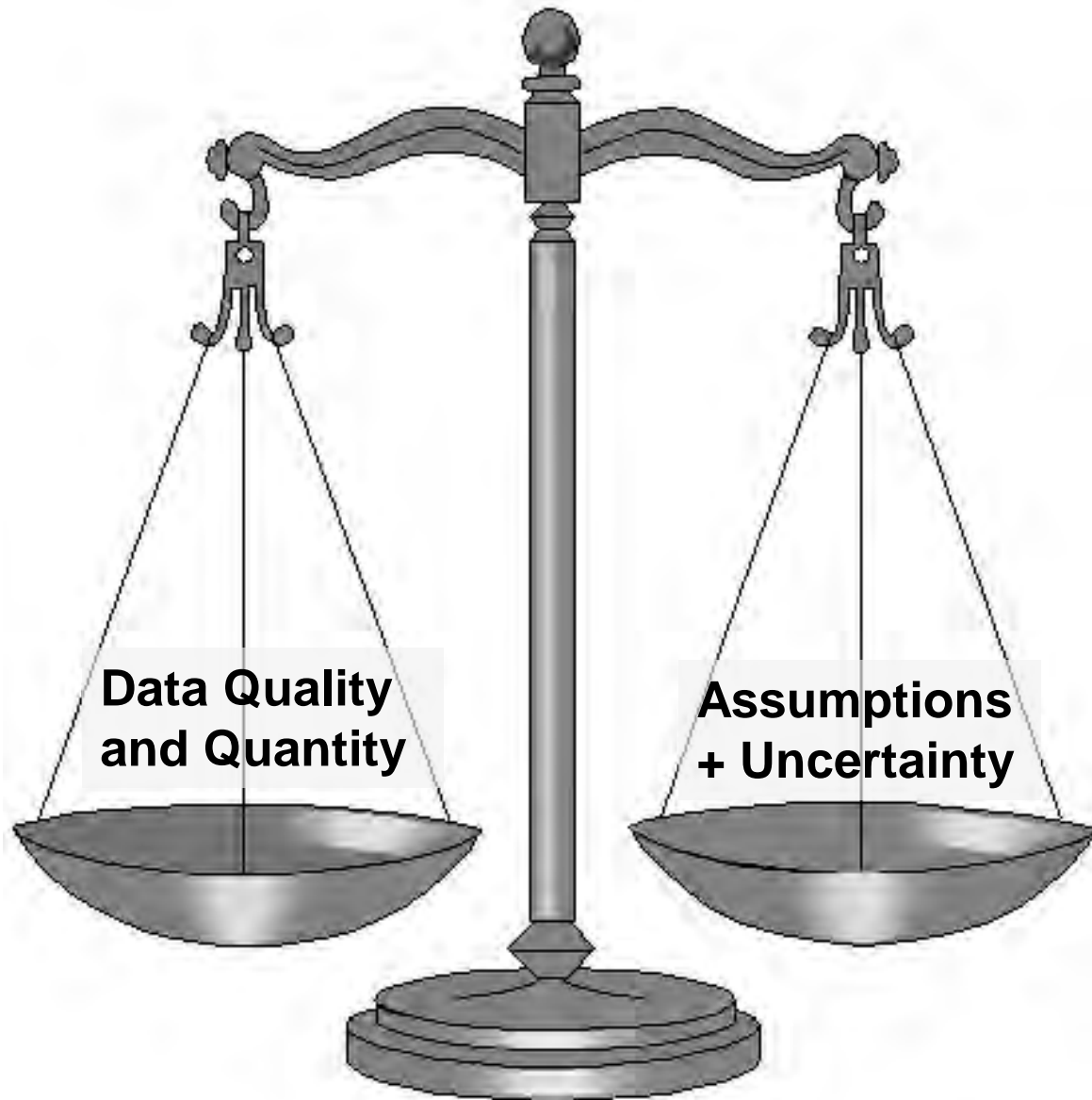
**Maraming
salamat!**

Todd Gedamke

Tom Daley
St. Croix Trap Fisherman

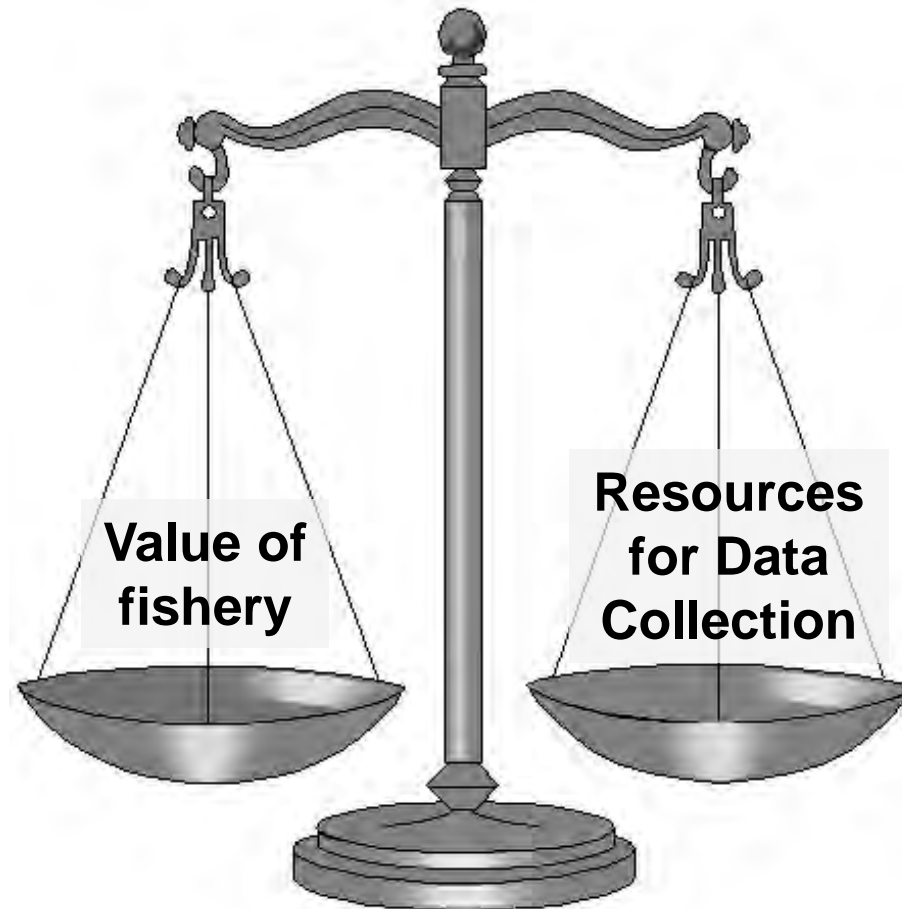


The Data Poor Dilemma



The Data Poor Dilemma

Value of fishery → \$'s for data collection
→ Low Data Quantity



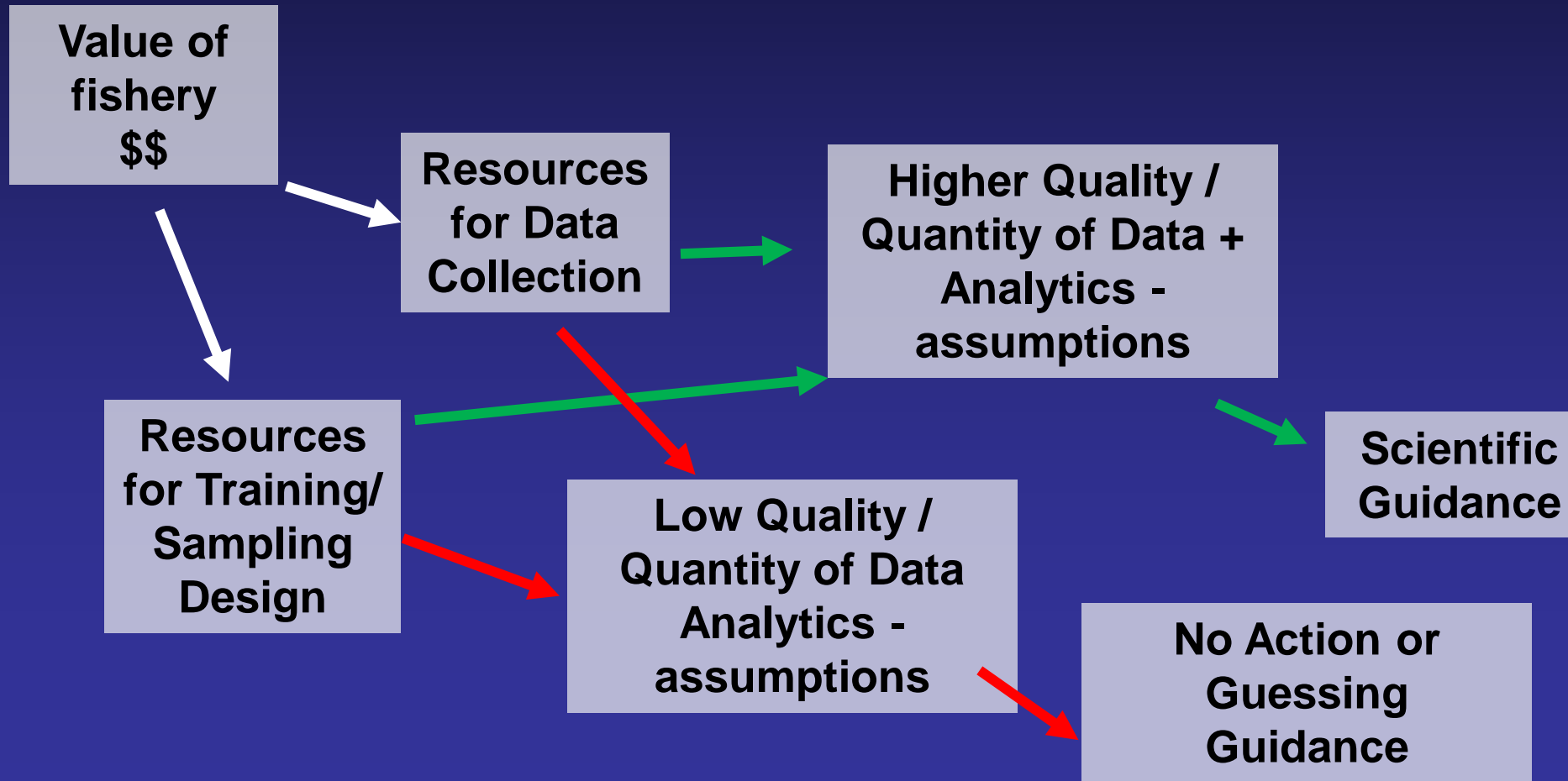
The Data Poor Dilemma

Value of fishery → Training of Fishery Dept.
→ Low Data Quality



The Data Poor Dilemma

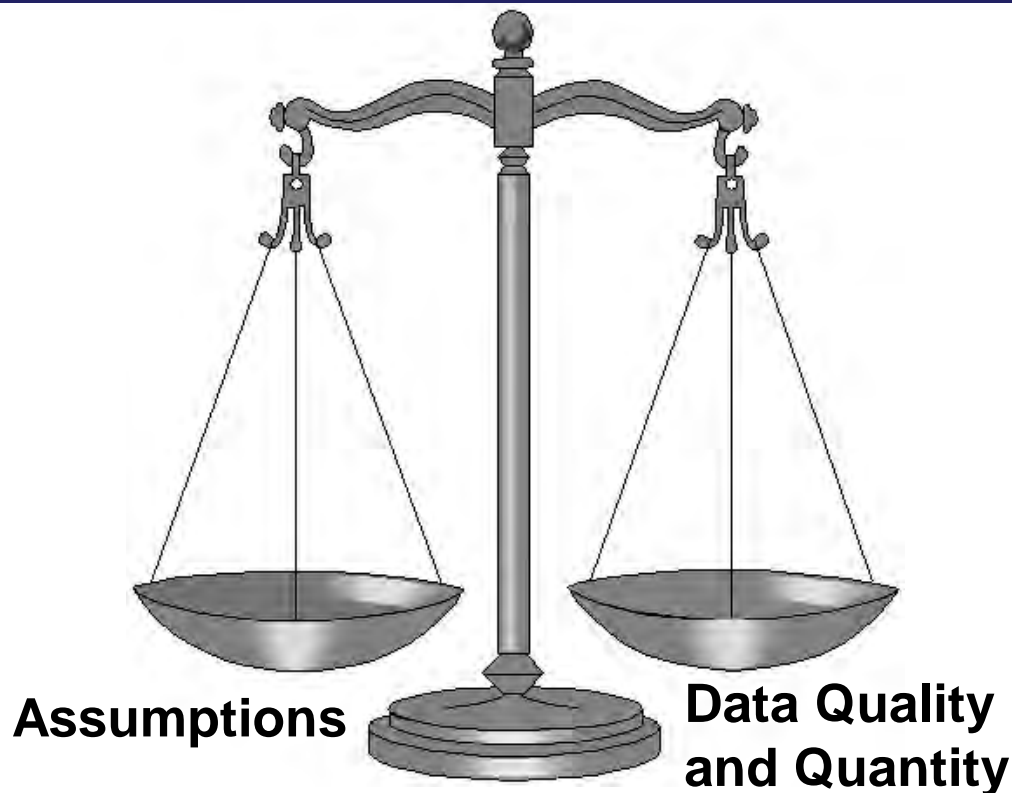
Need Data and Skills to Analyze



What can we do NOW??

Small Scale Fishery → NO Time Series of landings, CPUE, etc

Doing nothing not an option → Length Frequency



Quick Assess – Option 1

Estimate Mortality from Length Structure

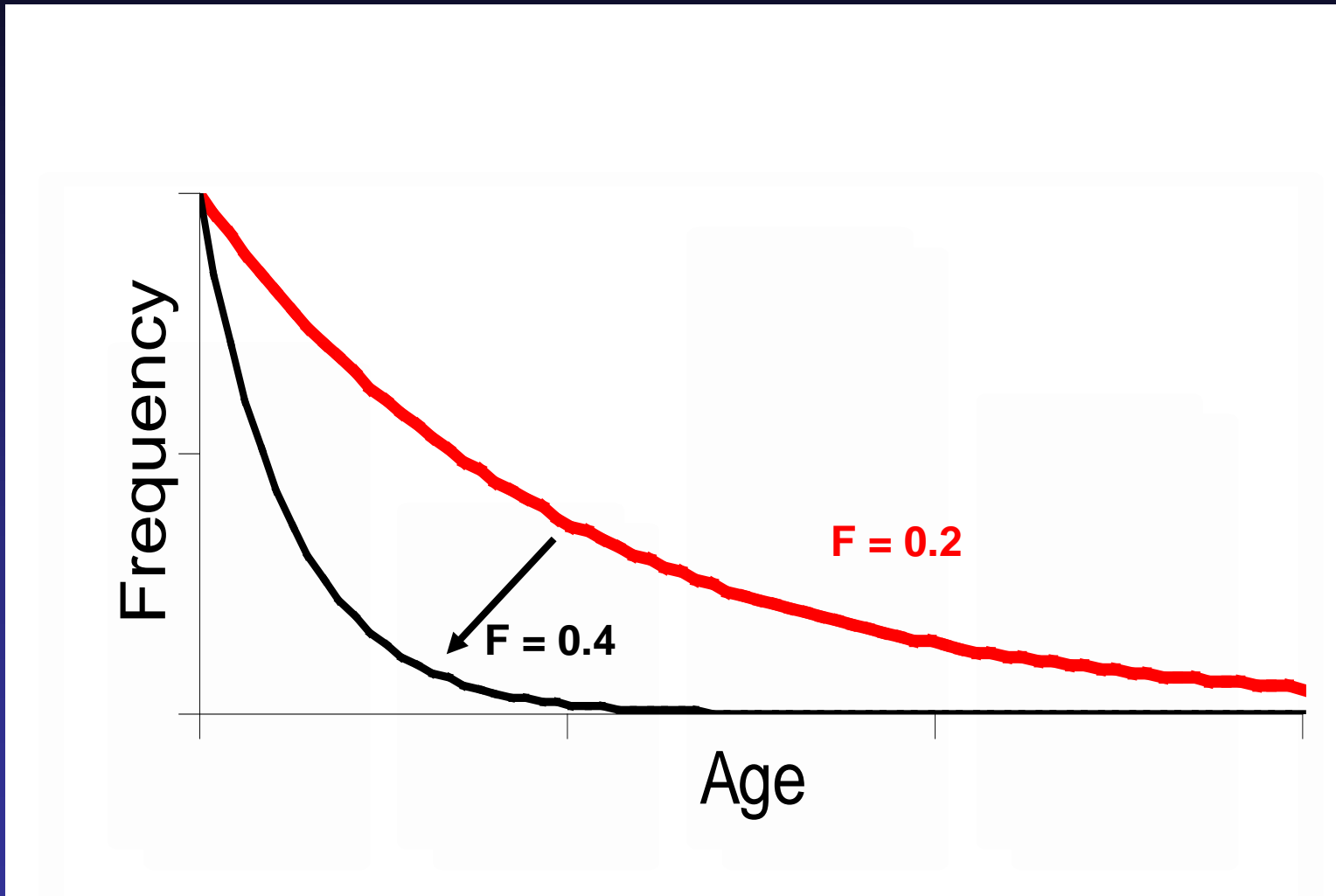
- Larger Fish → Less Mortality
- Need Natural Mortality to ‘Assess’ Stock

Length-Based Stock Assessments



Early Use of Length Based Methods—late 1800's

(Petersen, then Fulton, Baranov and others)



More Fishing → Less Older/Larger Fish

Beverton-Holt mean length mortality estimator

$$Z = \frac{K(L_{\infty} - \bar{L})}{\bar{L} - L_c}$$

5 assumptions:

1. **Asymptotic growth, K and L_{∞} known & constant over time. NEED AGE/GROWTH DATA**
2. **No individual variability in growth.**
3. **'Constant' & continuous recruitment over time.**
4. **Mortality constant with age (eg. Selectivity, M).**
5. **Mortality constant over time \rightarrow Population in equilibrium (mean length reflects mortality)**

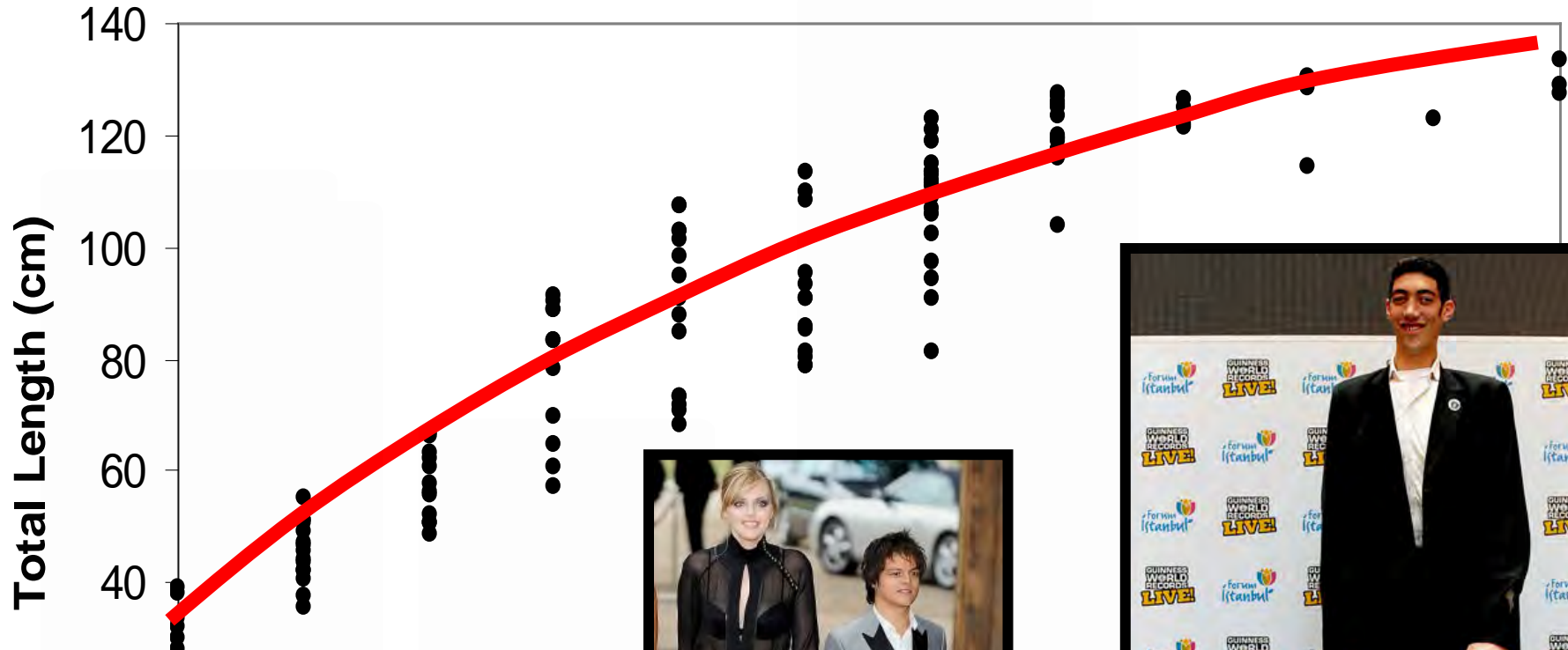
Beverton-Holt mean length mortality estimator

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3. 'Constant' & continuous recruitment over time.
4. Mortality constant with age (eg. Selectivity, M).
5. Mortality constant over time \rightarrow Population in equilibrium (mean length reflects mortality)

Evaluating Variability in Growth



3



7



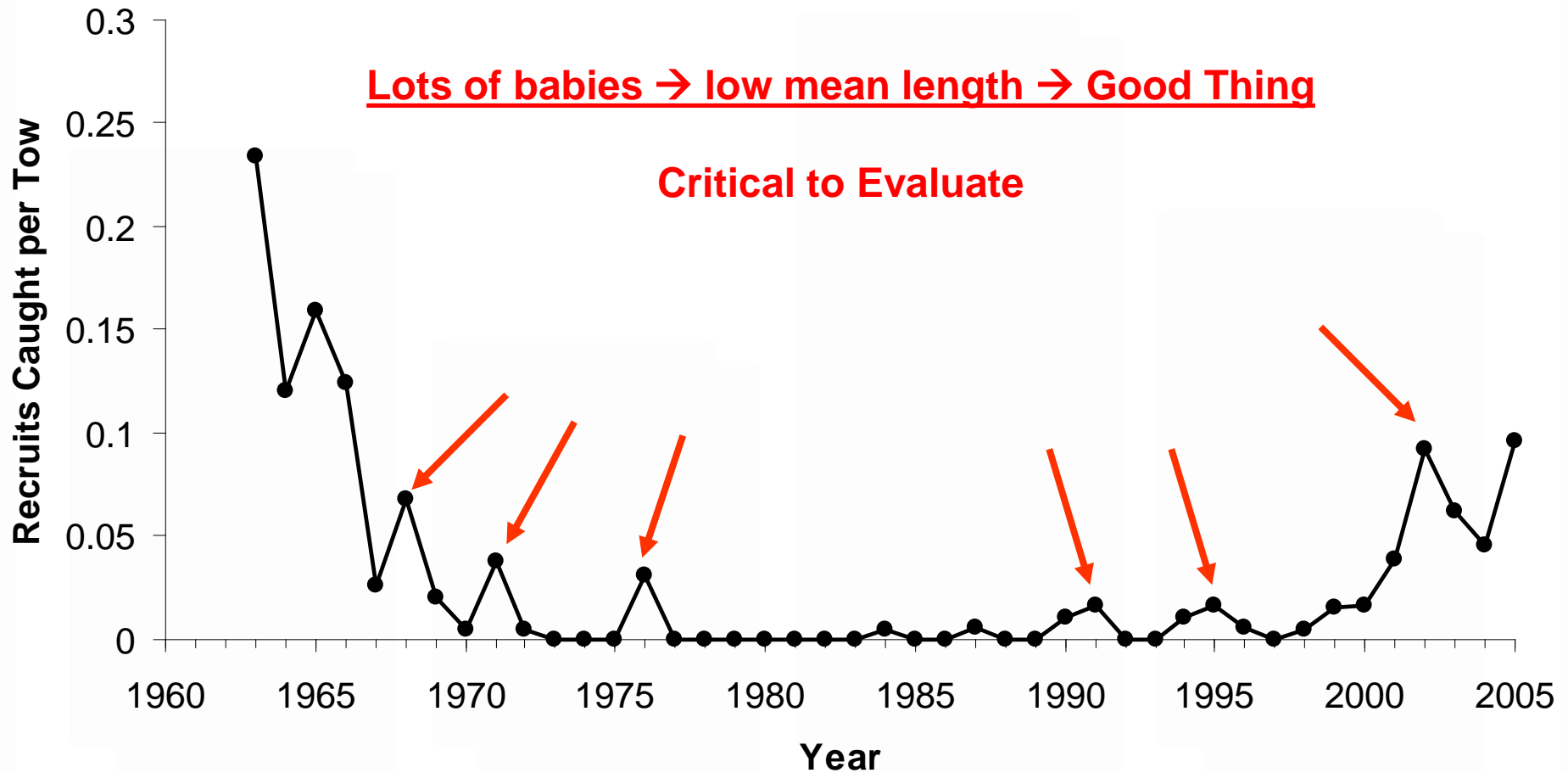
Beverton-Holt mean length mortality estimator

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3. **'Constant' & continuous recruitment over time.**
4. Mortality constant with age (eg. Selectivity, M).
5. Mortality constant over time \rightarrow Population in equilibrium (mean length reflects mortality)

Including Recruitment in Mean Length Analysis



Beverton-Holt mean length mortality estimator

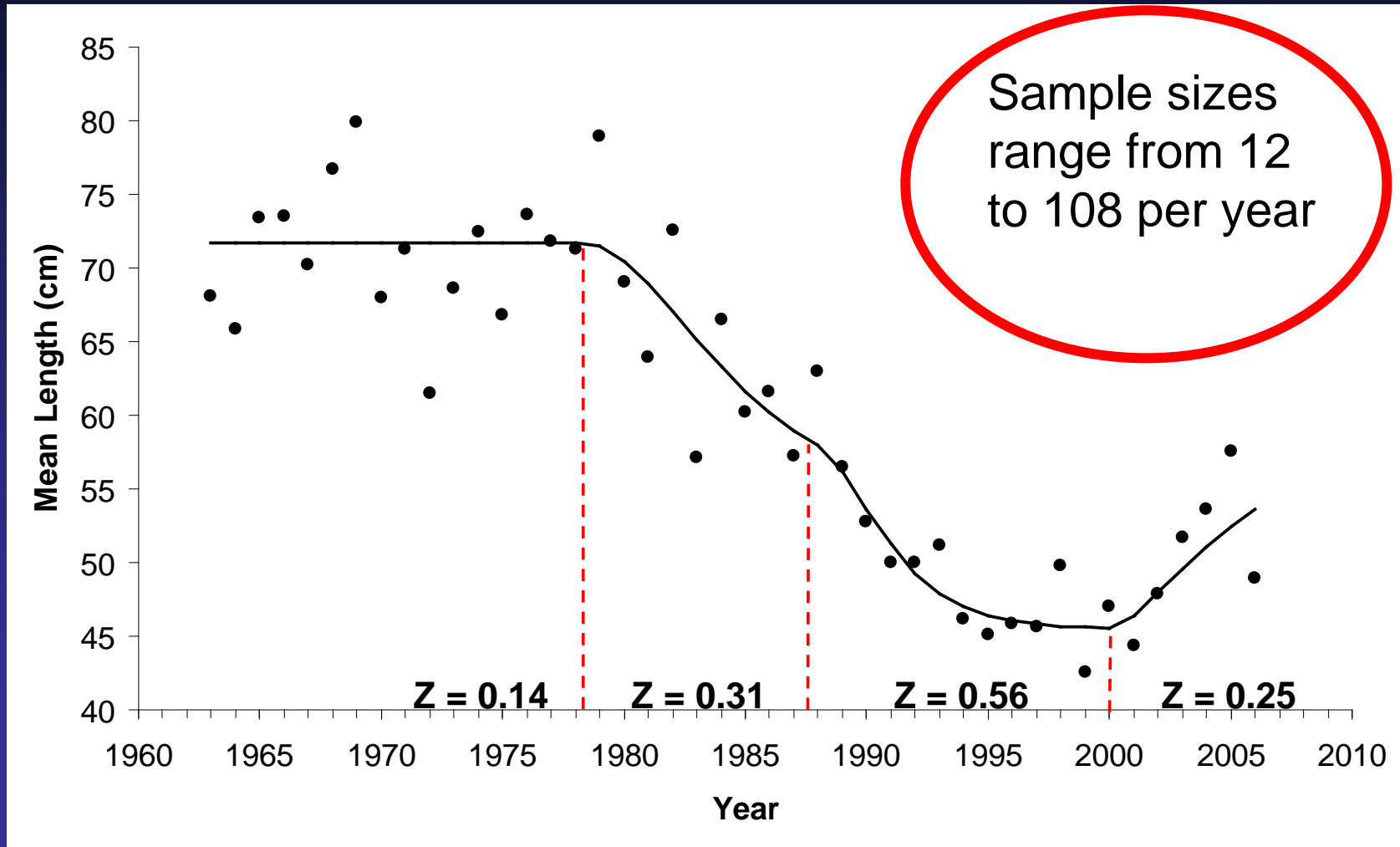
$$Z = \frac{K(L_{\infty} - \bar{L})}{\bar{L} - L_c}$$

5 assumptions:

1. Asymptotic growth, K and L_{∞} known & constant over time.
2. No individual variability in growth.
3. 'Constant' & continuous recruitment over time.
4. Mortality constant with age (eg. Selectivity, M).
5. Mortality constant over time \rightarrow Population in equilibrium (mean length reflects mortality)

Estimating Mortality from Mean Lengths in Non-equilibrium Situations

Gedamke and Hoenig (2006)



Quick Assess – Option 2

Proportion Mature in Catch

**100% mature Landings → ~0%
change of overfishing**

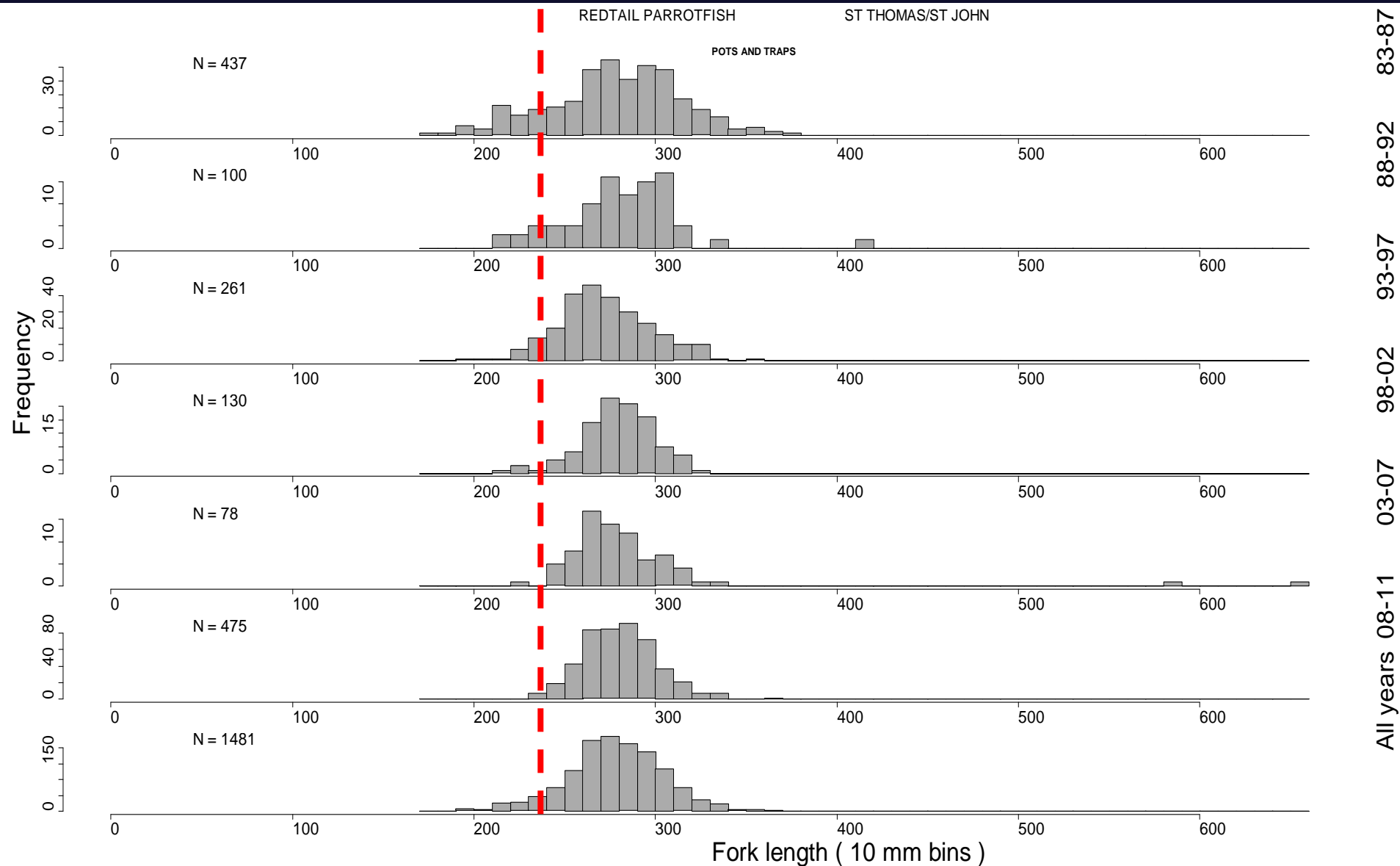
"Assessment of maturity in commercially and recreationally important reef fishes from the U.S. Virgin Islands"

Co-PIs are John Hoenig (VIMS) and Dr. Virginia Shervette (U of South Carolina).
Dr. Richard Nemeth, U.V.I. is a collaborator.

Common name	Scientific name	6y-cumul. landings (lbs)
Groupers/sea basses	Total	485,714
Coney-butterfish	<i>Cephalopholis fulva</i>	34,635
Red hind	<i>Epinephelus guttatus</i>	120,170
Triggerfish	Total	542,350
Queen triggerfish (ole wife)	<i>Balistes vetula</i>	146,368
Snappers/Lutjanidae	Total	1,089,369
Blackfin snapper	<i>Lutjanus buccanella</i>	40,337
Mutton snapper	<i>Lutjanus analis</i>	39,199
Silk snapper	<i>Lutjanus vivanus</i>	30,429
Yellowtail snapper	<i>Ocyurus chysurus</i>	92,771
Parrotfish	Total	1,376,730
Princess parrotfish	<i>Scarus taeniopterus</i>	41,335
Queen parrotfish	<i>Scarus vetula</i>	40,845
Redband parrotfish	<i>Sparisoma aurofrenatum</i>	31,369
Redfin parrotfish	<i>Sparisoma rubripinne</i>	37,812
Redtail parrotfish	<i>Sparisoma chrysopterus</i>	58,842
Stoplight parrotfish	<i>Sparisoma viride</i>	115,660



Length frequency distribution for redbtail parrotfish caught by pots and traps in St. Thomas/St. John.

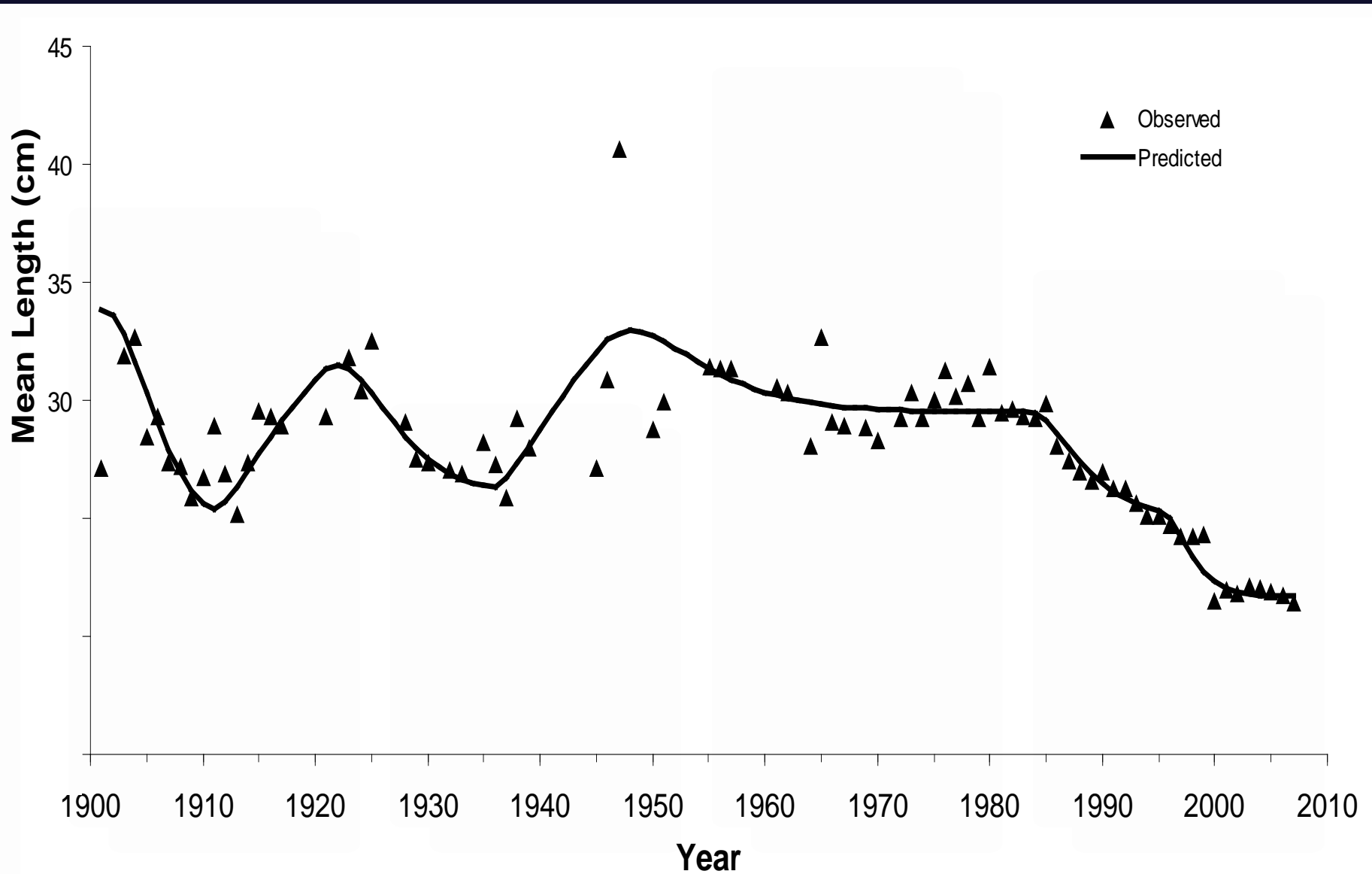


Quick Assess – Option 3

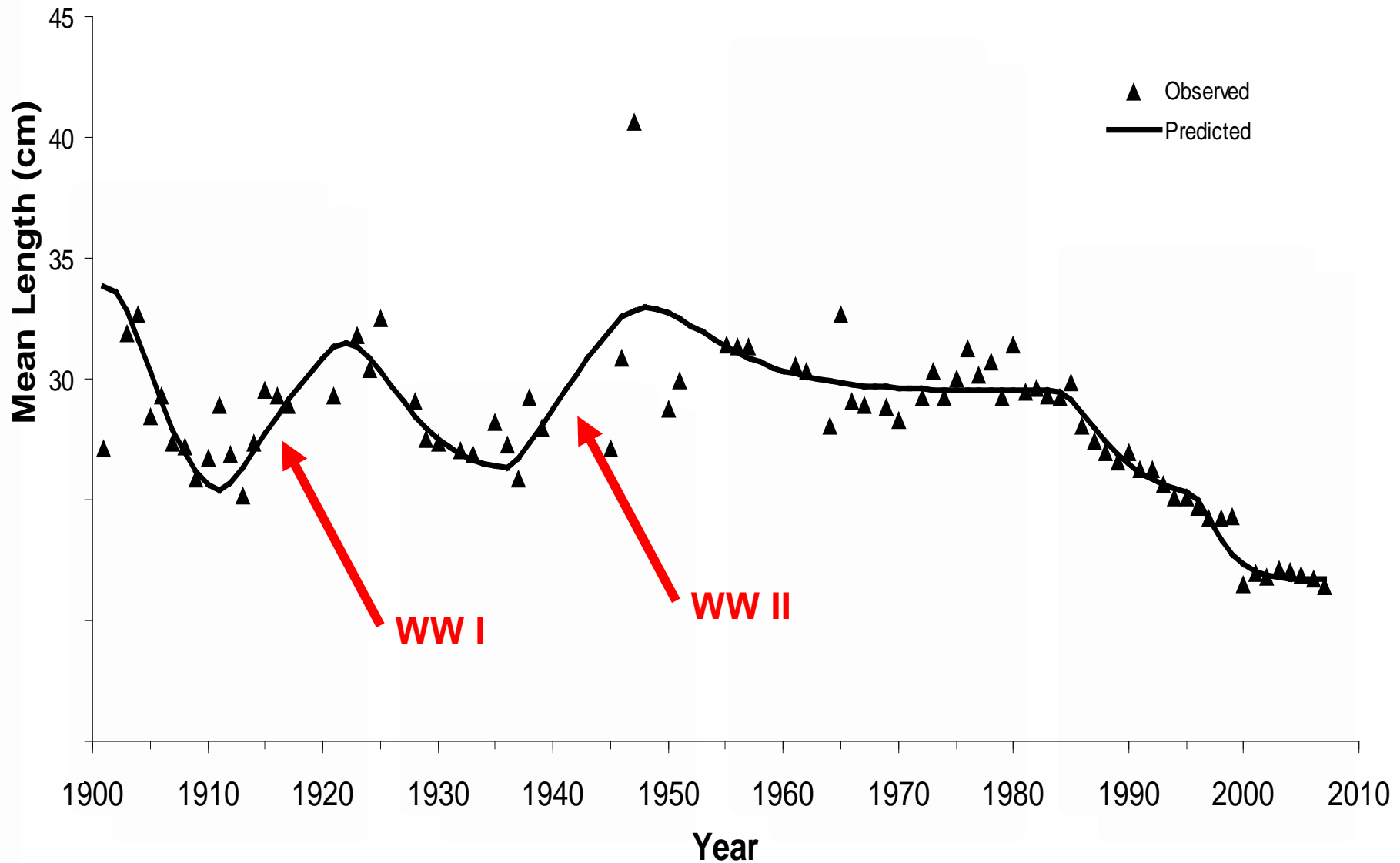
Monitor Trends in Mean Length →
Detect Changes in Mortality (w/
Assumptions)

**Do no harm! Maintain status quo until
enough data collected**

Modeling Historical Trends in Mean Length Plaice – Sweden Fishery Institute data from the North Sea



Modeling Historical Trends in Mean Length Plaice – Sweden Fishery Institute data from the North Sea



Caribbean Commercial Landings Validation Pilot Port Sampling Program United States Virgin Islands and Puerto Rico Fall 2015 – Spring 2016



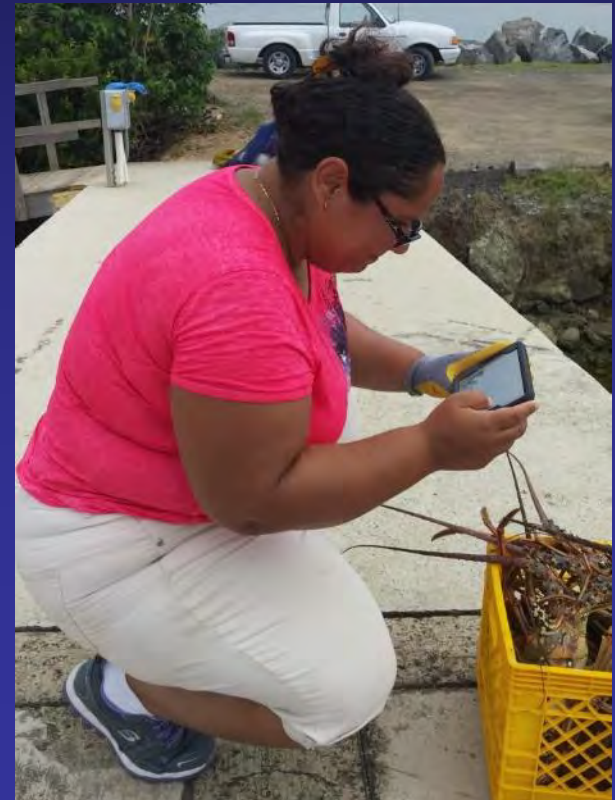
Todd Gedamke
MER Consultants

Electronic Reporting

- Samsung tablets w/ basic software
- Allowed for rapid evaluation of data and sampler performance
- Data stored locally – uploaded when online



Observed over
500,000 lbs to date



US Caribbean Pilot Port Sampling Program



SYNCHRONIZE

EMAIL HELP

Site surveys Trip landing forms

+ Add site survey

1. Sep 5, 2015, Altona Lagoon

2. Sep 5, 2015, Frederiksted Fish Market

Edit site survey

Sampler ID:

Site name:

Altona Lagoon

Site arrival time:

SEP 5, 2015, 13:18

Site departure time:

EDIT

Wind speed:

0-5 knots

Wind direction:

Light and variable

Precipitation:

None

Lightning:

None

Level of cooperation:

0 - Hostile

Num. sampled trips:



Port Sampling Supervisor Page

Date: 2015-09-21
Device / sampler ID: 7196376d44739938 - LMM
Site survey: 6. SAG 2015-09-21 12:49:51.0 - 2015-09-21 21:00:35.0

Download KMZ



< 1 of 34 >

Category: Parrotfishes Species: Parrotfish, stoplight Update

Logout

LOGIC /EVOLUTION OF THE PROJECT/WHY?

Experience - How many fish have you measured? How many times did you do it alone? Did taping counters to a measuring board to do it alone feel like progress? We have the technology....



The US Caribbean Challenge:

Problem we're addressing began as a multispecies issue. Every fish in these relatively small but species rich landings took too long to sort by species.

Every fish here



has to be handled/touched to get to a sorted before weighing them here:



Why move every fish 2 times?!?

This doesn't usually translate to efficiency in manpower in the US Caribbean or any other fishery:



PREVIOUS EFFORTS TO SIMPLIFY DATA COLLECTION AND REPORTING FOR LENGTH FREQUENCY DATA



Our First Thoughts:



Chair sitting in for cooler with scale underneath.

Tablet

Houses app. When triggered by weight output, camera takes image of fish on scale tray. After image and weight data are gathered, beeps to let sampler know to move on.



App

Inputs data from scale, collects image data, signals for next fish. Creates data stream that can be integrated into sampler form data.

Scale serial interface

Can provide weight data in stream or command mode, so can be gathered and/or controlled by app. Also has relay output that can trigger other devices, like light box. Output cable can be USB or 9 pin connector.



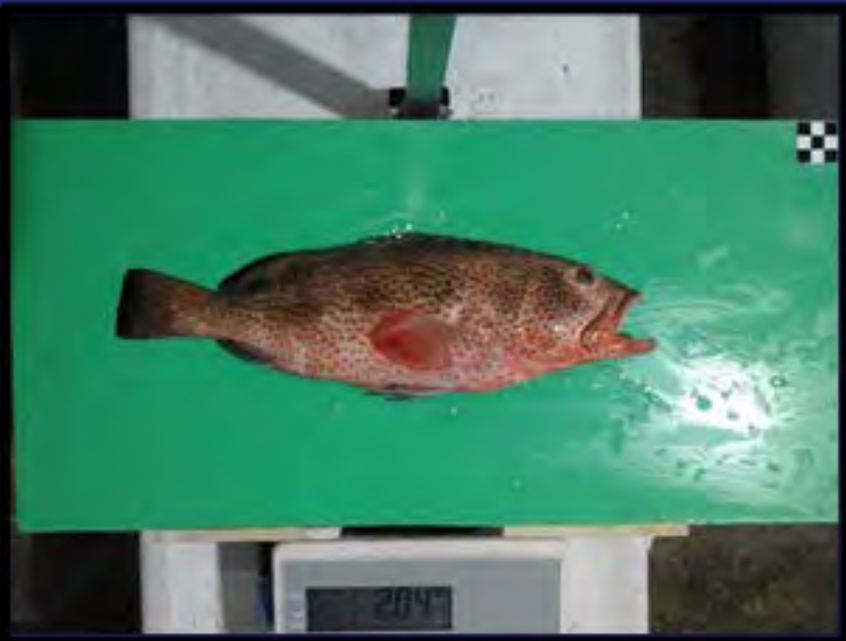
Multi-Device Synchrony →
Scale Stabilizes →
Picture is Triggered →
Photo + weight saved →
Ready for next fish

Scale

Main considerations are "stabilization time" (i.e. how long takes load cells to settle and get true reading), and managing measurement error. Minimum stabilization time is 1 sec. Measurement error multiplies through with cumulative weighing because not clearing load cells in between. But probably not an issue realistically.

Laser sensor
Could also trigger other instruments.



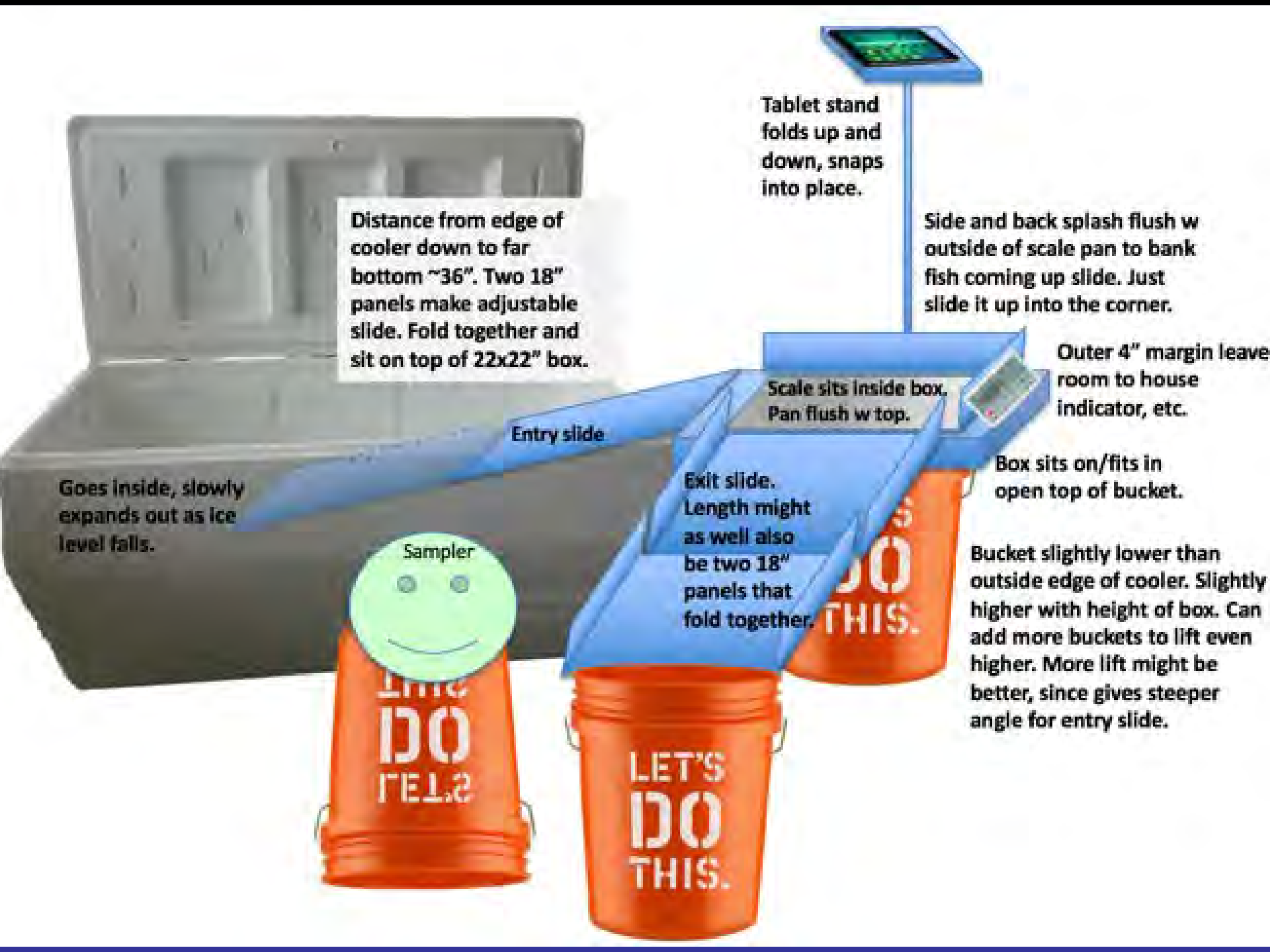


Prototype 1



- **Mobile/ compact - one person (e.g., dockside, boat, in water , on trailer, on ramp, under a tree, etc.).**
- **Clean and quick flow of components and sampler movements so each fish can be measured in ~2 seconds.**
- **Durable for reality of field work (e.g., samplers will want to carry inside bucket etc)**





Distance from edge of cooler down to far bottom ~36". Two 18" panels make adjustable slide. Fold together and sit on top of 22x22" box.

Tablet stand folds up and down, snaps into place.

Side and back splash flush w outside of scale pan to bank fish coming up slide. Just slide it up into the corner.

Outer 4" margin leave room to house indicator, etc.

Scale sits inside box. Pan flush w top.

Box sits on/fits in open top of bucket.

Goes inside, slowly expands out as ice level falls.

Entry slide

Exit slide. Length might as well also be two 18" panels that fold together.

Bucket slightly lower than outside edge of cooler. Slightly higher with height of box. Can add more buckets to lift even higher. More lift might be better, since gives steeper angle for entry slide.



FULL STATION SETUP

Sites where can bring fish to station.

- Saga Haven
- Hull Bay
- Frenchtown
- Frederiksted

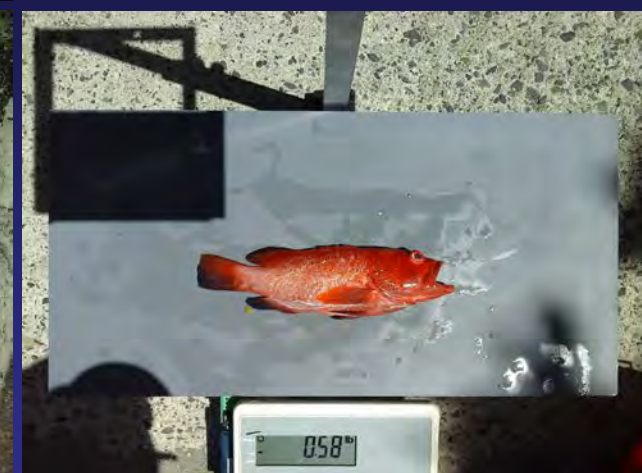


Prototype 2



**CAPATURING IMAGES IN
CONSULT WITH
COMPUTER VISION
CONSULTANTS.**

Backgrounds and Lighting



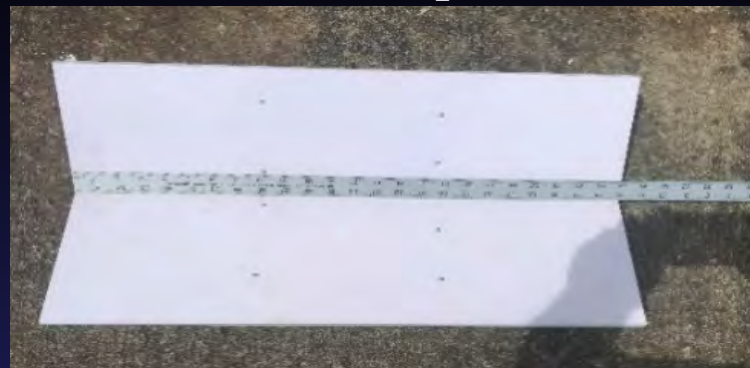
CAPTURING IMAGES IN CONSULT WITH COMPUTER VISION CONSULTANTS.

Background Shapes

Flat Surface



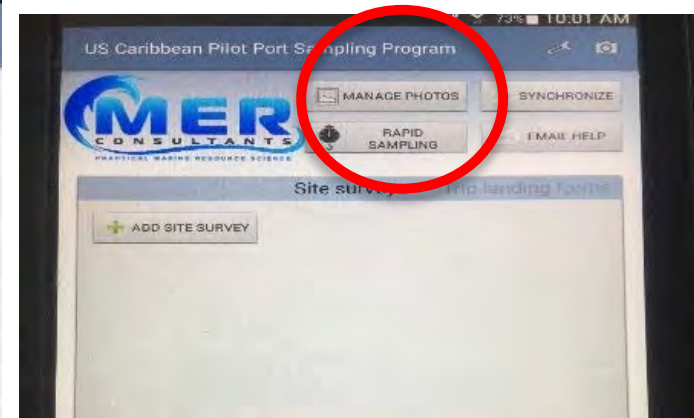
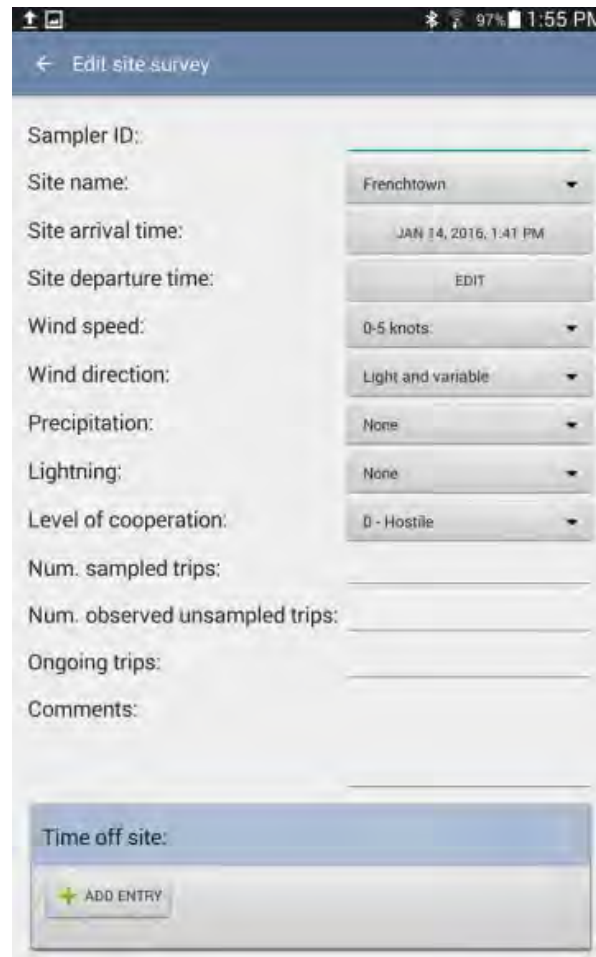
V" Shape



U" Shape



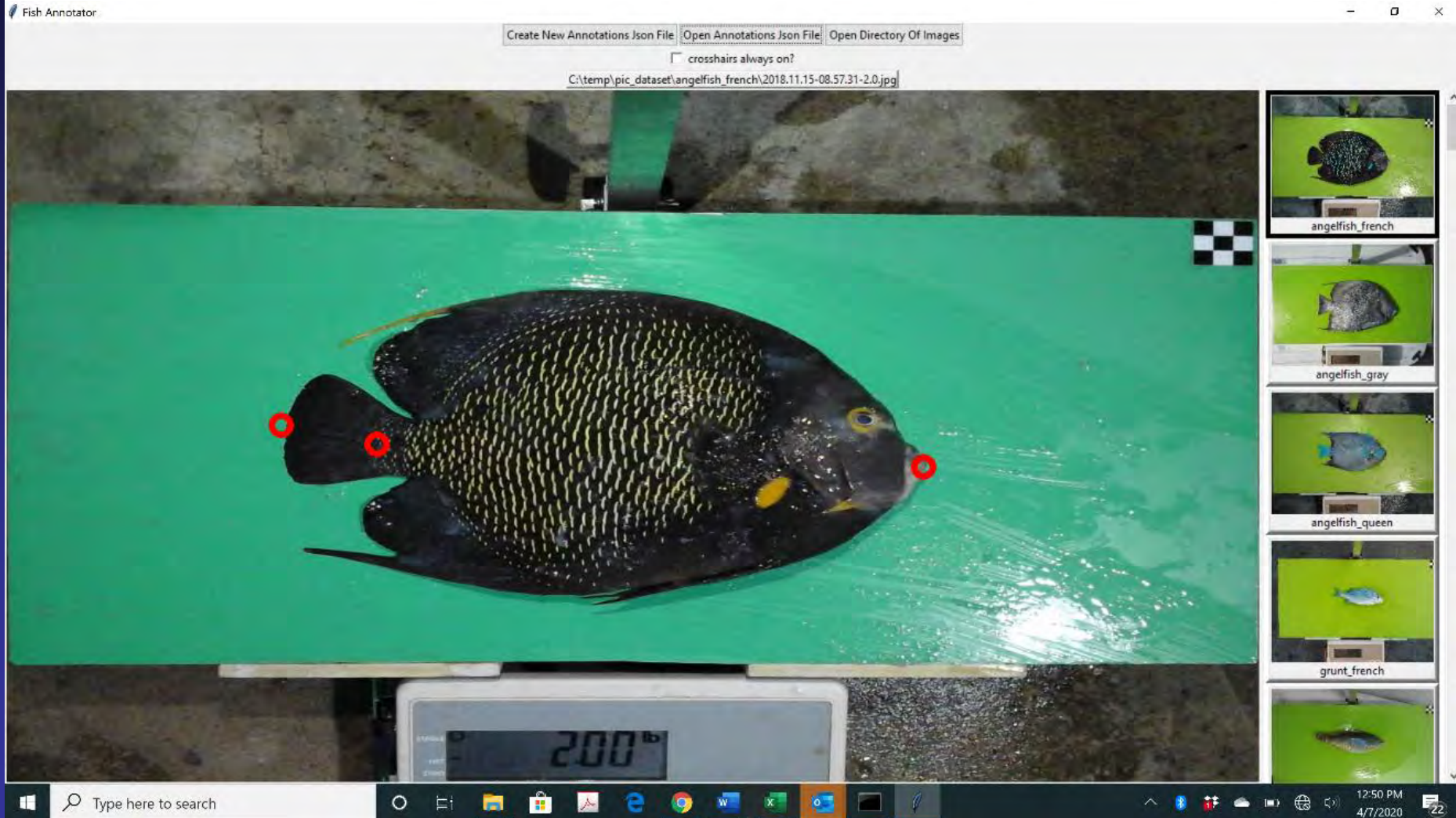
Site survey home screen in data entry application – Addition of Rapid sampling/Photo capture module on right.



Over 20,000 images logged to date

Annotation Software

Annotation software was developed using Python and a basic spectral analysis of each photo to suggest species. Annotation points are indicated by red circles and suggested species are in the right thumbnails.

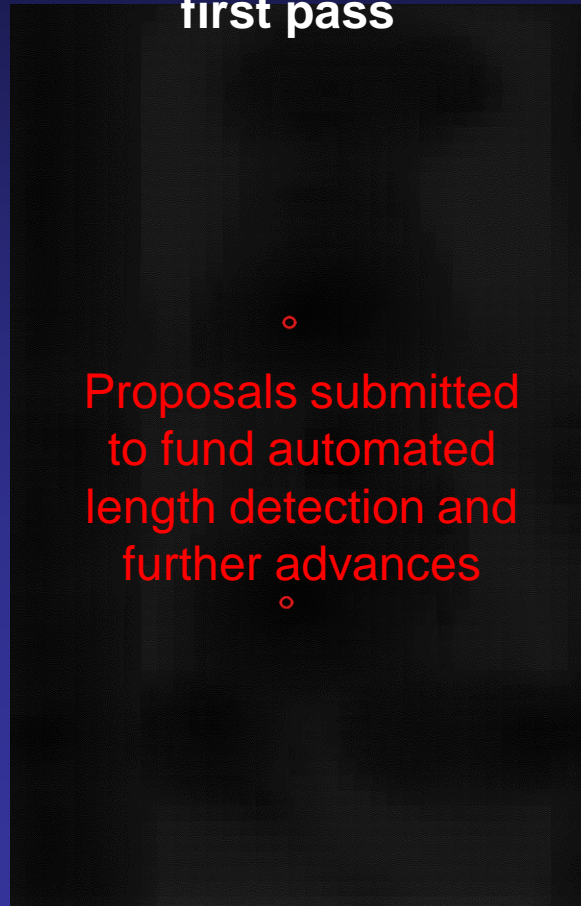


PRELIMINARY LENGTH DETECTION ALGORITHMS

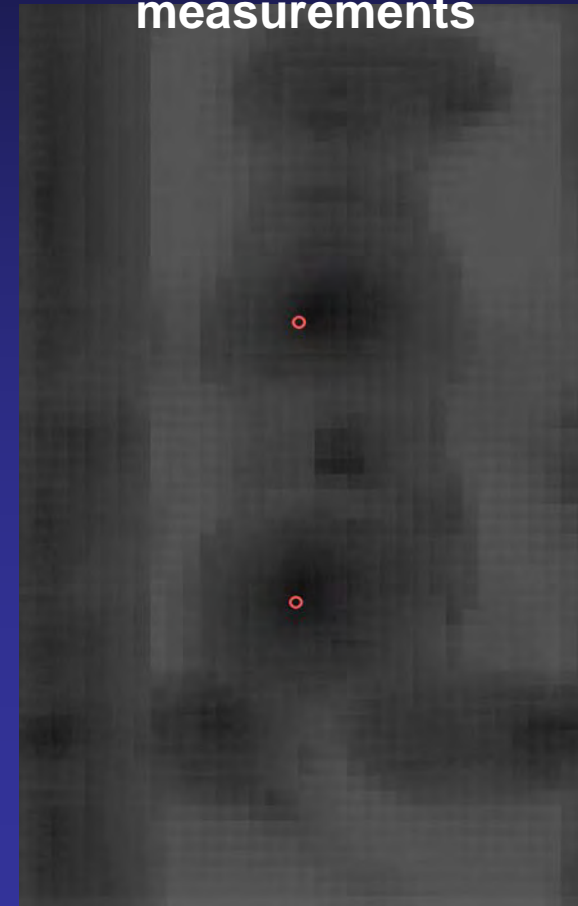
Original picture



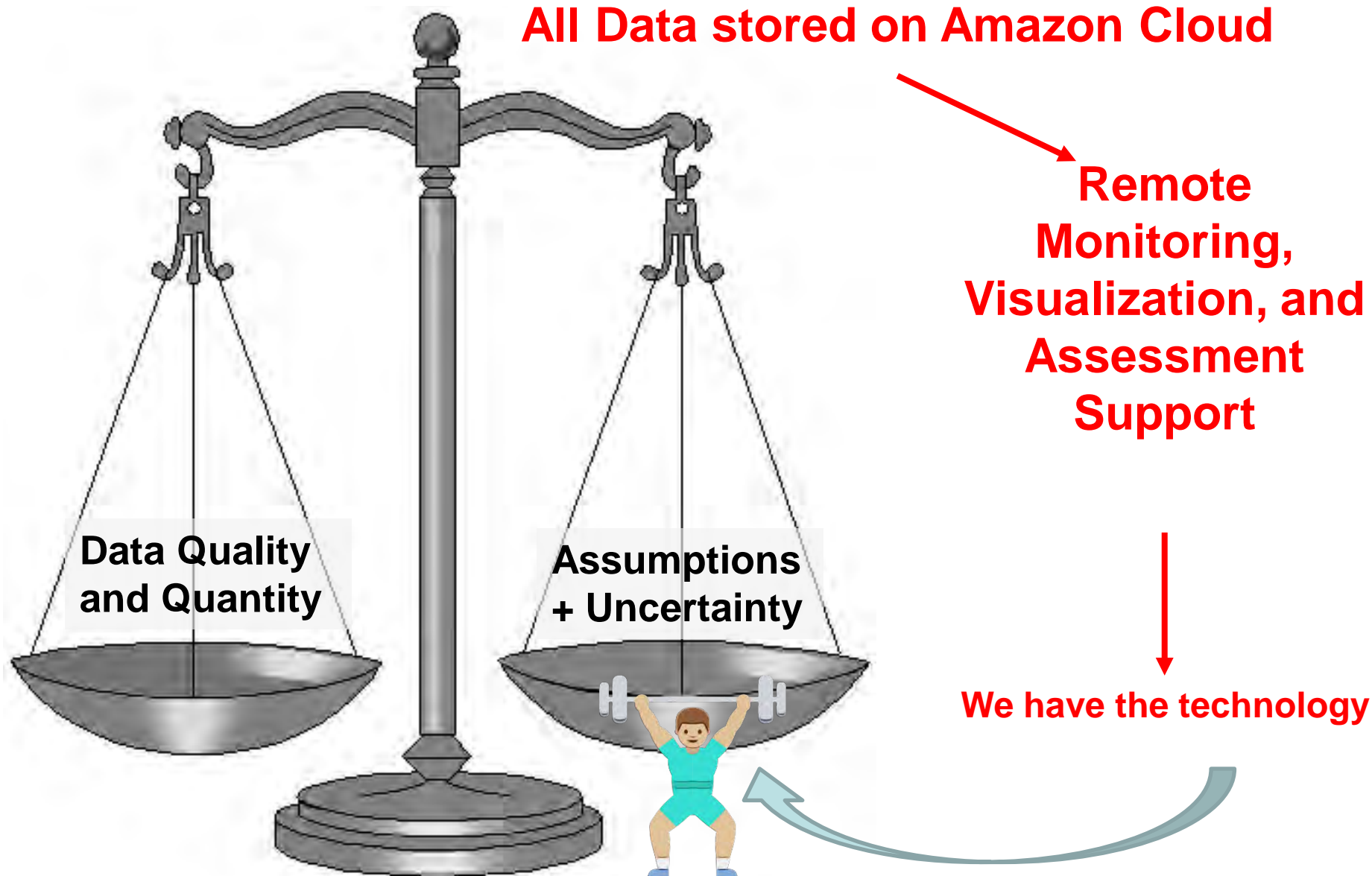
Annotated for length
(red dots) - algorithm
first pass

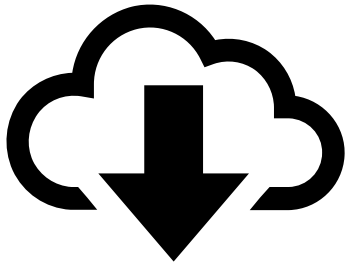


Heat map of probability
of points for
measurements



The Data Poor Dilemma

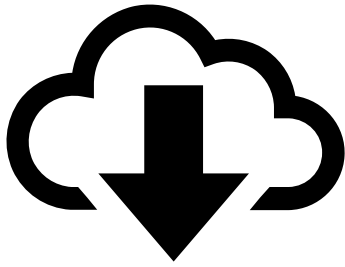




CUSTOM DASHBOARDS



- We build user-friendly dashboards that process your data, conduct analyses, produce reports, and support effective communication with diverse audiences.
- Each dashboard is custom designed to each unique fishery.
- We use R Shiny for its user-friendly interface. Our team writes the code, your team uses the interface.
- Customization is where R Shiny *shines*



DASHBOARDS DESIGNED TO EMPOWER



- Carry out technical tasks correctly and on time.
- Rapidly improve technical capacity.
- Ensure continuity of fishery management plan implementation
- Services *can* include on-going scientific oversight and incremental improvements to dashboard features
- Customization is key to serving varying levels of technical capacity.

MOTIVATING EXAMPLES

Data-limited stock assessment Periodic reporting & analysis

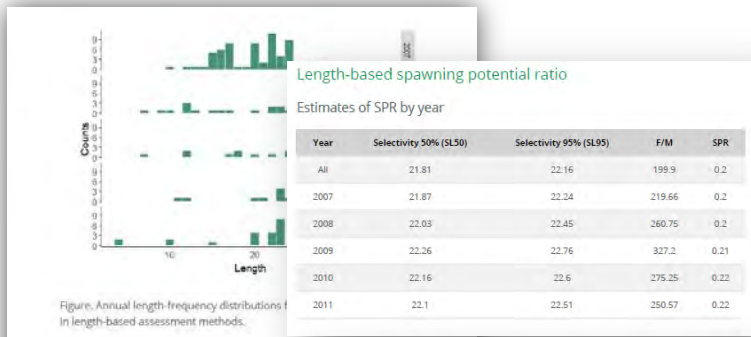


Figure. Annual length-frequency distributions in length-based assessment methods.

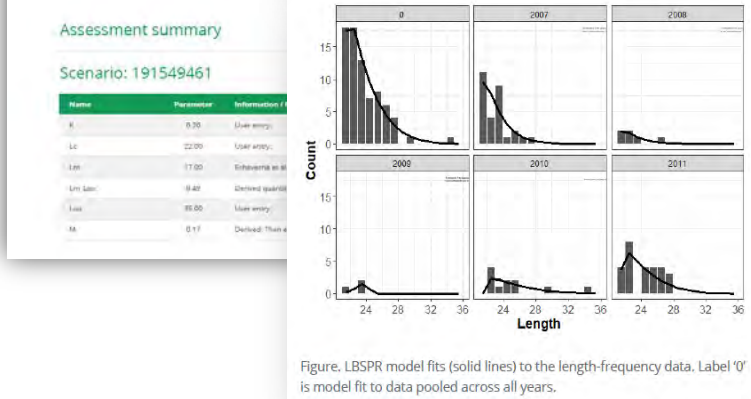


Figure. LBSPR model fits (solid lines) to the length-frequency data. Label '0' is model fit to data pooled across all years.

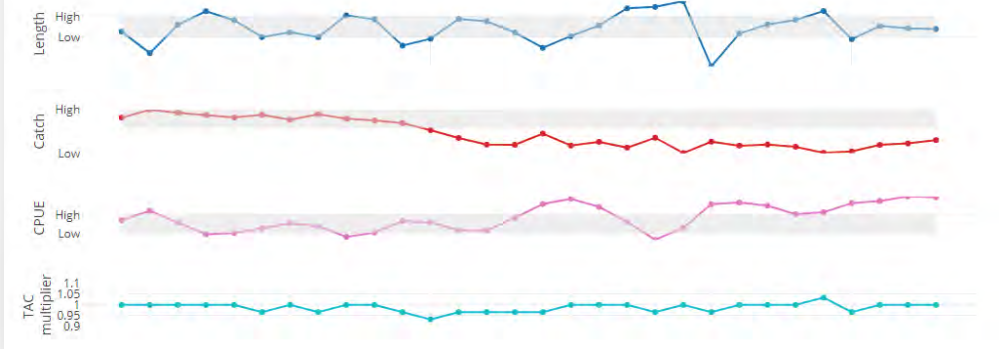
Harvest strategy implementation

Figure 1: Incremental TAC adjustments in response to changes in indicators

Three indicators are used in the AMF: density, average length and catch

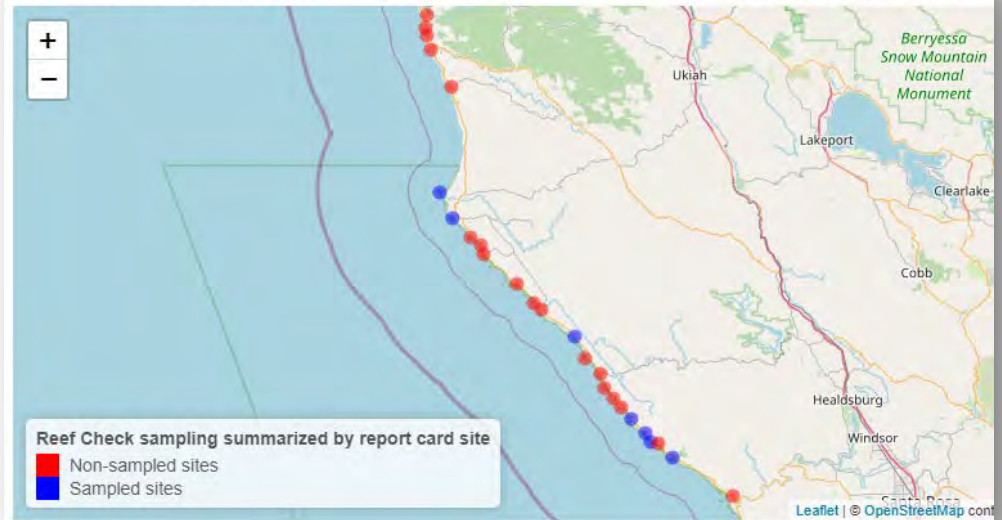
Observe that as indicators go beyond specified tolerances (shaded areas), the TAC is adjusted

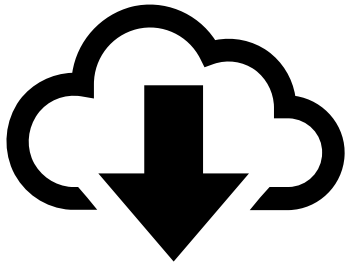
These indicators work in partnership to determine the strength and direction of the TAC adjustment



Community engagement

Reef Check sampling for northern California red abalone summarized by report card site





OUR SERVICE APPROACH

- *Each dashboard or application is a custom designed stand-alone product.*
- *Where can additionally provide on-going support, overseeing/carrying out data processing, analysis, and reporting.*

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Thank You!!