Science, Service, Stewardship

Pacific RecFIN Comparisons – Searching for a Calibration

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Outline

- Background
- Objectives
- Examples of survey comparisons
- Consideration of calibration
  - Calibration concepts
  - Possible calibration of MRFSS with new State Surveys
  - Possible combination of survey estimators
- Unresolved problems and uncertainties
- Strategies for survey improvements

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Background

- Pacific RecFIN implemented new and modified survey designs in 2003 due to:
  - Changing management needs
  - Perceived problems with the MRFSS effort estimates
- MRFSS conducted 1981-1989 and 1993-2002
- MRFSS overlapped with OR and WA surveys 1998-1999
- MRFSS telephone survey continued in 2003-2005 to allow comparisons with new effort surveys
- RecFIN Statistical Subcommittee tasked to look into “calibration of new sampling methods” against MRFSS.

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Objectives

1. Quantify differences between MRFSS and State Survey effort estimates during the period 2003-2005.

2. Identify features contributing to observed differences.

3. Evaluate possible calibration of “old” and “new” surveys to develop more accurate time series of recreational fishing effort estimates.

4. Identify improvements needed in “new” State Surveys.

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Surveys Compared

- MRFSS:
  - Coastal Household Telephone Survey (CHTS)
  - Access-Point Angler Intercept Survey
- Washington Ocean Sampling Program (OSP)
- Washington Puget Sound Sampling Program:
  - Angler License Directory Telephone Survey (ALDTS)
  - Puget Sound Intercept Surveys
- Oregon Ocean Boat Survey (ORBS)
- Oregon Shore and Estuary-Boat Survey:
  - Angler License Directory Telephone Survey (ALDTS)
  - Access-Point Angler Intercept Survey

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Specific Comparisons

- Washington Puget Sound:
  - Total annual effort: PSSP vs. MRFSS
  - Mean angler effort: ALDTS vs. CHTS
- Washington Ocean:
  - Total annual effort: OSP vs. MRFSS
- Oregon Inland:
  - Total annual effort: SEBS vs. MRFSS
  - Mean angler effort: ALDTS vs. CHTS
- Oregon Ocean:
  - Total annual effort: OSP vs. MRFSS

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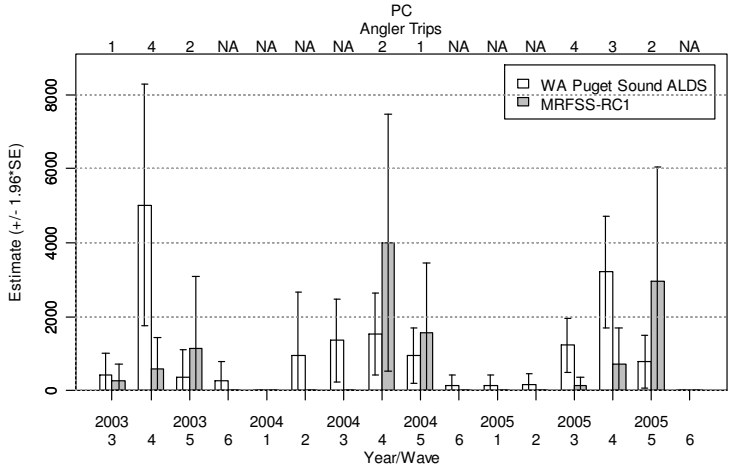
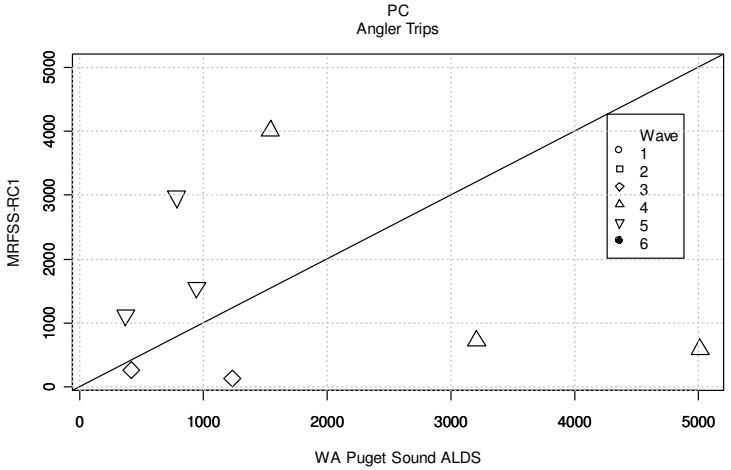
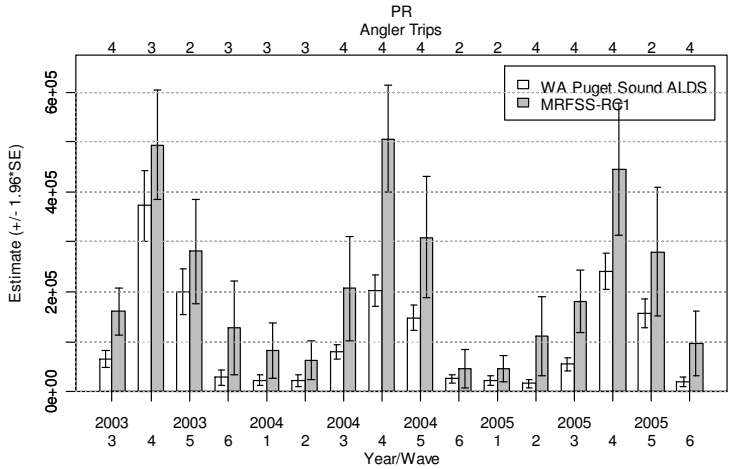
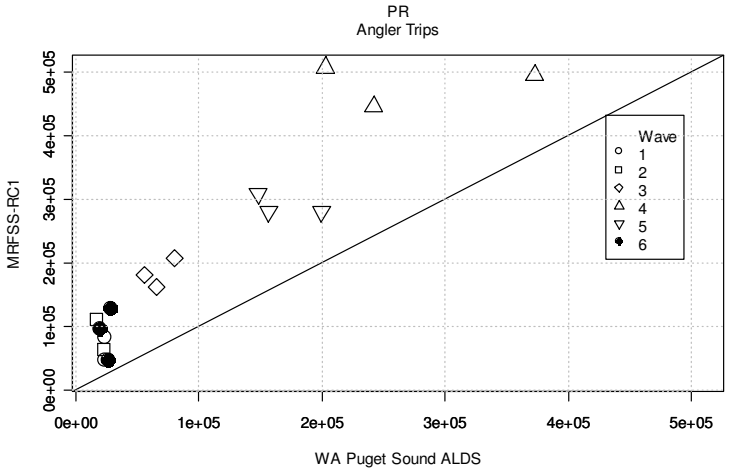
Total Fishing Effort









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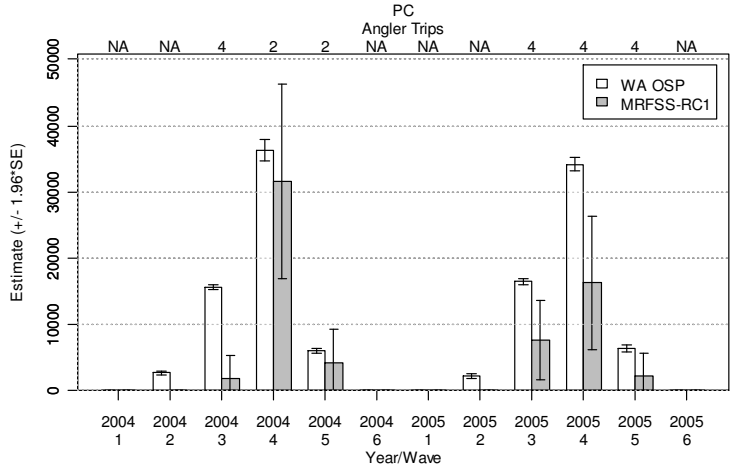
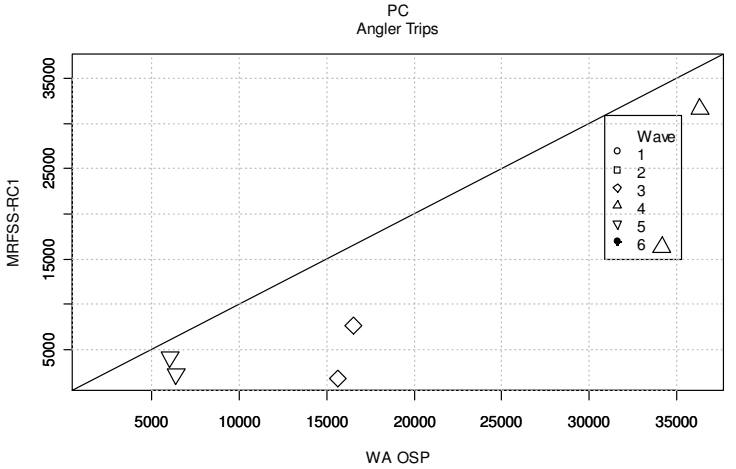
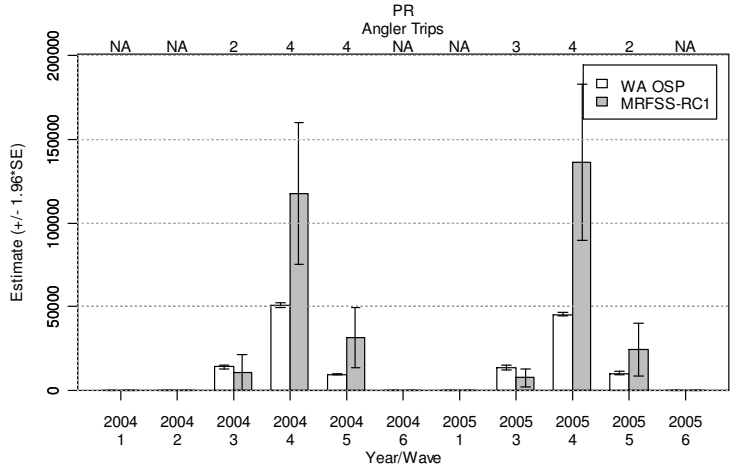
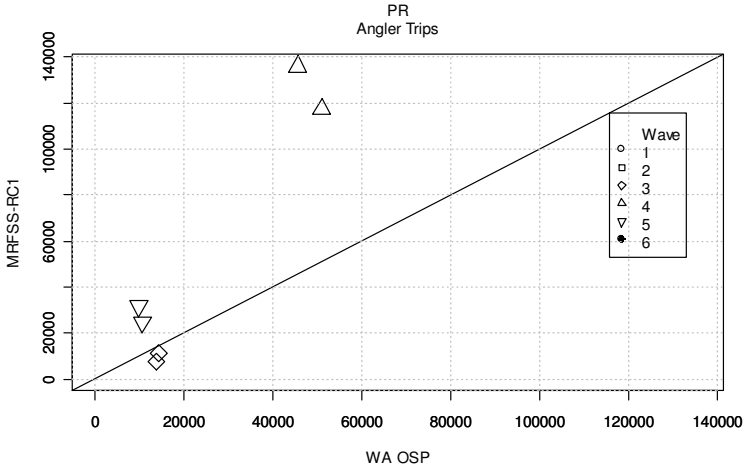
Total Fishing Effort









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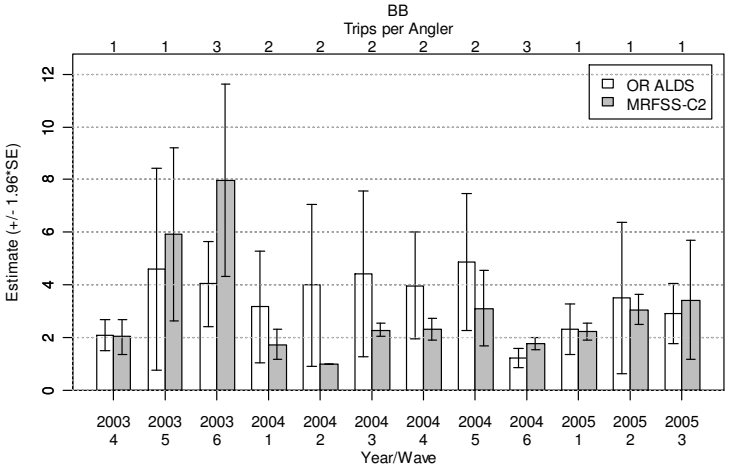
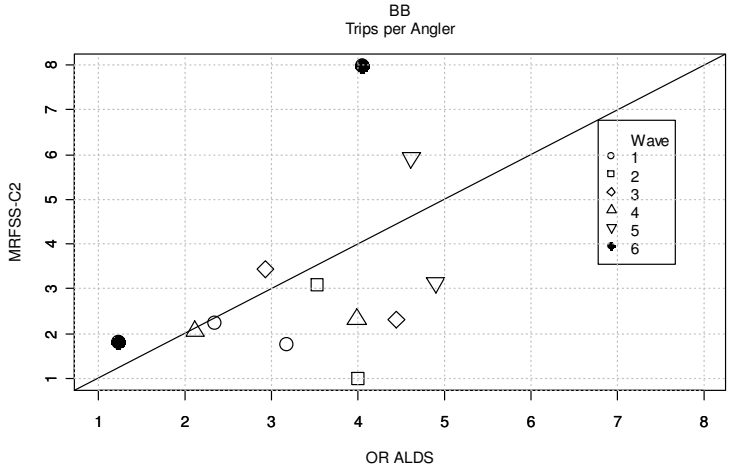
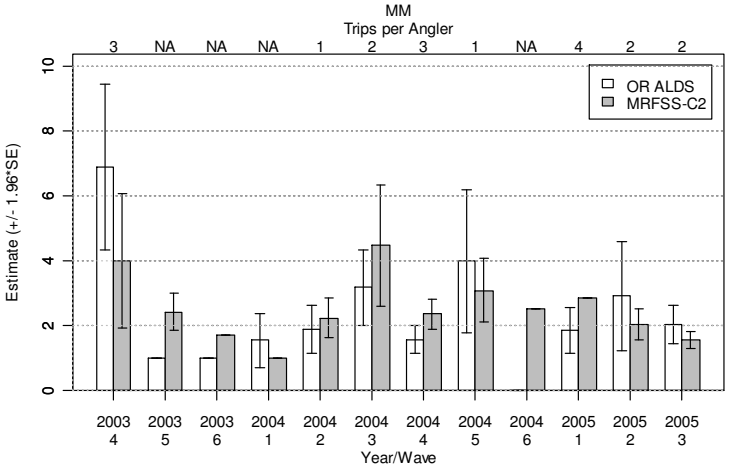
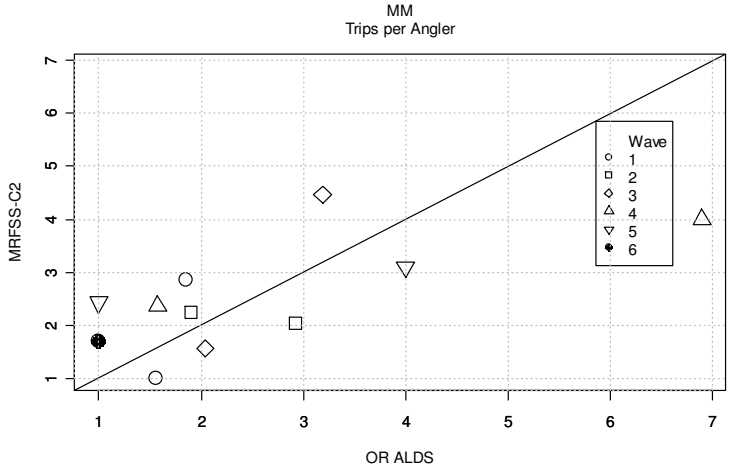
Mean Effort per Angler









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Traditional Calibration

- Calibration of one method of measurement to another
  - Method M1 is available (but perhaps not standard)
  - Method M0 is regarded as a standard (or reference)
  - M1 is “calibrated” to M0 within acceptable accuracy criterion
  - M0 need not necessarily represent “truth” any more than does M1
  - Examples:
    - Thermometer I1 measures Fahrenheit temperature (M1)
    - Thermometer I0 measures Celsius temperature (M0)

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Stages of Calibration

1. Find a calibration function – f(M1)
2. Use f(M1) to convert the M1 measurements to the M0 standard values.

Examples:

- Convert T1 temperature in Fahrenheit to T0 standard temperature in Celsius – linear calibration function
- Calibrate fish weight or age to length – calibration functions may not be monotonic

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Calibration Concepts
"Scientific" Calibration

- Concerned with experimentally validating use of a proposed calibration function.
- NIST has set up validation criteria which call for "traceability" – complete information about every step in a process chain of comparisons, with accompanying uncertainty statements.

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Calibration Concepts
"Statistical" Calibration

- Concerned with theoretic methodology for defining suitable calibration functions and uncertainties between given measurement methods.
  - Inverse regression
  - Inverse prediction

- In most familiar cases, one method is deemed a standard or reference, and so "absolute" calibrations are made to it.

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Calibration Concepts
"Comparative" Calibration

- Applied when no one method can be deemed as standard, and calibrations are made among all methods.

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Calibration of MRFSS and State Surveys

- All surveys were subject to both sampling errors and non-sampling errors:
  - None meet NIST standard for serving as the “reference” or “gold standard” measurement.
  - None set up as controlled experiment – no way to perform “ground truthing”.
- No replicate specimens within each survey domain (i.e., mode and wave)
  - NIST-type calibration experiment not possible
  - No way to establish unbroken chain of comparisons and provide statement of uncertainty within & between surveys.

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Calibration of MRFSS and State Surveys

- There was vast diversity in comparisons of estimates among survey domains
  - Simple calibration that aggregates all domains will introduce untraceable bias
  - Meta-analysis would require further auxiliary data (now lacking) to interpret diversity unequivocally.
- The surveys have limited temporal overlap.
  - Any calibration function between survey estimates will be very problematic extrapolation to times where one or both surveys offer no data.

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Calibration of MRFSS and State Surveys

- There was obvious variability both within and between surveys.
  - Variability is mode-and wave-dependent.
  - A given survey may nominally be the “same” survey from one year to the next, when in fact its methods have evolved as improvements were implemented.
  - Consistent calibration within/between surveys doubtful
- The form and features of appropriate calibration functions are unknown:
  - Linear versus nonlinear, or univariate versus multivariate

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Possible Calibration?

- Objective:
  - "Assess whether it is possible to calibrate the old and new survey estimates in order to maintain a continuous time series of recreational fishing effort."
- Conclusion:
  - Meaningful and reliable calibration is very problematic - essentially impossible - in the cases of MRFSS vs. state surveys

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Argument against Calibration

- Stock assessments should make optimal use of all available data from the different surveys:
  - Past data from “old” surveys
  - Recent data from “new‘ surveys
  - Both kinds of data from “continuing‘ surveys
- Stated concern regarding the “calibration” of effort estimates may be viewed more appropriately as a concern about how best to combine different survey estimators to produce one estimate

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Combined Estimators

- Linear compromise estimators
  - Two estimators are weighted and combined into one
  - Weighting often based on estimated variances of the estimators – one with higher variance gets less weight
  - MRFSS and OSP, or MRFSS and ORBS?
- Dual-frame estimators
  - Two surveys (A and B) use different sampling frames and neither provides complete coverage of the target population.
  - The frames have some degree of overlap
  - Compromise estimator for A/B overlap domain can be combined with A & B estimators for non-overlapping domains
  - ALDTS and CHTS?

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Combined Estimators

- Multiple-frame estimators
  - The dual-frame method extended to multiple surveys
  - Multiple estimators can be combined if certain linkages are established between their frames
  - MRFSS and CRFS?
- Measurement-error models
  - A very general approach toward use of multiple sources of information (used in stock assessments)
  - “Error-in-variables” models are a common subset
  - For same reasons that calibration is problematic, measurement error models would be difficult to use here

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Combined Estimators

- Multiple Indices
  - Powerful modeling practice is to use several estimates (or indices) of the same quantity from different sources
  - Typical fishery stock-assessment model uses several indices of each stock's abundance
  - Analysis may not require a compromise estimate
  - Use of separate estimates allows model to use more information
  - Model itself, through its population dynamics or other components, may well be able to reconcile (at least in part) the differences among the separate estimates.

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Unresolved Issues

- Not clear which survey estimator is closer to the truth – no single method is known to be unbiased.
- Time period of overlaps very short – comparisons may not sufficiently reflect differences expected in earlier years.
- Data collection programs have not been static
  - MRFSS in1980's not the same as MRFSS in 1990's
  - Newer surveys evolving during overlap period.
- Differences observed are not systematic – likely that environmental/regulatory changes play a major role.

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Possible Sources of Bias

- Non-sampling errors due to undercoverage and non-response
- Methods of estimation not weighting data properly to reflect sampling design
- Methods of imputation *ad hoc* in some cases
- Errors in implementation of sampling and data processing protocols
- Multi-purpose surveys not optimized for all species
- Small sample size – “empty” estimation domains lead to “zero” point estimates or variance estimates

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Recommended Improvements

- Improve sampling frames for better coverage
  - Include all sites in frames used for on-site surveys
  - Develop angler and vessel registries
  - Use multiple frames where possible
- Reduce nonresponse and develop appropriate nonresponse error corrections if possible
  - Redesign questionnaires
  - Improve outreach and education of participants
  - Collect relevant variables for nonresponse adjustments

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Recommended Improvements

- Reduce measurement and implementation errors
  - Provide/upgrade training for samplers/interviewers
  - Improve quality assurance and quality control
  - Automate data entry and transfer
  - Improve database management
- Improve estimation
  - Amend estimation procedures to be in accord with sampling design
  - Evaluate imputation methods
  - Use domain and small area estimation methodologies

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Recommended Improvements

- Combine multiple survey estimators into one
  - Use expert collaboration to obtain and apply optimum weights to each estimator
- Review issues of survey costs versus sample size to optimally balance trade-offs and achieve desired levels of statistical precision
  - Optimize sampling allocations both within and among component surveys
- Improve survey documentation

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Pacific RecFIN Statistics Subcommittee

- WDFW – Jennifer Cahalan
- ODFW – Bryan Wright
- CDFG – Joe Weinstein, Meisha Key
- PSMFC – Wade Van Buskirk, Rod Pederson, David Cassell
- NMFS NWFSC – Todd Lee, Nick Tolimieri
- NMFS SWFSC – Keith Sakuma
- NMFS ST – Rob Andrews, Han-Lin Lai, Dave Van Voorhees