DATA POOR METHODS IN THE SE US

NRDC/MOORE

1/15/14

Participants: 9 or 10 stock assessment scientists from SE region plus 8 or 9 outside experts

David Newman: review of US FMPs – how are ACLs set?

* 2000: ¼ of assessed stocks were subject to overfishing
* 2007: 1/5 of assessed stocks were subject to overfishing
* 2014: less than 9% of assessed stocks were subject to overfishing
* But 166 stocks and stock complexes are not assessed, some are likely subject to overfishing
* Bentley and Stokes 2009: definition of data poor stock – insufficient information for stock assessment
* Data moderate: some data providing dynamic feedback on stock status to inform catch advice
* Data poor: static assumptions about stock status with only catch or less, sometimes informed by expert judgement
* 212 stocks data rich, (18%) 235 data moderate (19%), 598 data poor (50%), 159 (13%) exempt
* Stock complexes: 50% data poor
* Pacific: tiny fraction of catch - data poor
* Gulf: most catch exempt, small amount data poor
* SA: more data poor catch
* Caribbean: all data poor
* Pacific: mostly DBSRA
* Gulf: mostly one SD above mean of average landings as ACL
* SA: mostly 3rd highest catch over time period as ACL
* Big value to managing minor stocks, ecosystem, forage benefits

Tom Caruthers – evaluating data limited methods

* Can bring over critics by putting them into the shoes of fishery manager faced with ACL requirement – forced decisions
* MSE: operating model, program data limited methods, specify how unknown the unknowns, performance metrics
* Evaluated six life history types
* Tested methods: DBSRA, DCAC, Fmsy/M, ORCS control rule berkson et al 2011, catch percentiles
* Metrics: probability of overfishing, yield
* For mackerel type fishes: DBSRA, Fmsy/M methods – high yields, low probability of overfishing (dynamic methods superior to static methods). Results vary dramatically according to stock status
* Snapper type fishes: DBSRA best (highest yields, lowest probability of overfishing) – results vary dramatically according to stock status
* Butterfish type fishes: all methods converge (short-lived, fast growth)
* When we think stock is at 100 or more% of unfished B, catch scalar is chosen as 120 – 180% of maximum catch, results in high probability of overfishing
* MSE showing tendencies, not necessarily what would happen because prudent management is not simulated
* DBSRA sensitive to bias in estimated depletion (much more so than to variation)
* Suggests that intensity of survey (higher variation) can be low if design is good (low bias)
* \*what is range of depletions at end of simulation that correspond to highest yields? About 0.3-0.5
* Data moderate methods (Fmsy/M and DBSRA dynamic) outperformed other methods at all biomass levels but are very sensitive to biased estimates of abundance or depletion
* DBSRA and DCAC are most appropriate for long-lived species
* Average catch rules performed badly
* Maximum catch rules performed badly

John Hoenig – empirical estimators of M based on length composition

* Estimating M from comparative life history studies (Pauly using k, Linf, T; alverson and carny k, Tmax, hoeing Tmax 1983, Jensen k1996
* How good are these methods?
* Prediction error estimated for each method (against 201 literature values for M)
  + One parameter Tmax estimators worked best (5.02/Tmax)
  + Hoenig (adding k) about as well as Tmax (maximum age)
  + Alverson and Carney work worse
  + Jensen, Pauly – worst
* Averaging estimates across methods doesn’t reduce prediction error
* Average difference between estimated M and literature values is 0.3
* Pauly and Jensen methods provide higher M estimates than Hoenig method
* \*are there life history differences between species with M above and below regression line of M on Tmax?
* Fishery can greatly increase sample size and probability of sampling very old fish, so this can drive Tmax up
* Length based methods assume equilibrium, Z constant with age, Z constant with time, constant recruitment or random fluctuation, no variability in size-at-age
* If only havce average length, use Beverton Holt to estimate Z, Gedamke Hoenig method
* If fishing effort data are available, use Then-Hoenig-Gedamke method
* If catch and CPUE data are available use THG model (outputs q, M, Ft, Zt), then surplus production model to get MSY, Bmsy, Fmsy, Ft, Bt
* Increasing recruitment (lots of small fish) could make average length go down and Z appears to be higher; cpue could go up and Z appears lower
* If data on multiple species caught together are available, get mean length for multiple species, use multispecies Gedamke-Hoenig (period Z by species)

Meaghan Bryan – Non-equilibrium length based estimation (SE science center NOAA)

* Very limited life history information, lots of uncertainty in input paramters
* OFL = Fmsy\*some measure of abundance (N)
* If average catch over a reference period is kinown and have an estimate of F, we assume avg catch = Fref\*Nref
* Used Gedamke-Hoenig mean length estimator to estimate Z by time period (attractive for species with only length comp data plus k and Linf – non equilibrium method)
* Puerto Rico queen snapper
  + Time series of catch but no effort data
  + Time series of size comp data
  + Contradictory growth parameters
  + Z insensitive to changes in Lc, somewhat sensitive to changes in Linf, but very sensitive to k
  + Probability of overfishing quite sensitive to the benchmark (F0.1/Fref = 46% probability of overfishing; Fmax/Fref = 11% probability
  + F ratios are fairly insensitive to uncertainty in life history paramters

Jerald Ault – Extending length-based assessment methods

* Florida fishing: $10 billion/yr, reef fishing worth about $6 billion/yr (more than citrus)
* Short life histories with low Lmax/Linf show large bias at equilibrium (fast growth, lead to overestimation of F)
* Hogfish snapper average length time series suggests that stock is below MSY
* Yellowtail snapper average length time series suggests that stock is at about MSY
* Very high exploitation rates in south Florida, many species appear to be experiencing overfishing
* Changing size limits would probably help
* Evaluation of data poor and data rich models against data
  + DBSRA underestimate F early in time series but converge on F estimates based on Lbar and ASPIC at end of time series

Q and A

* Carl Walters: mean length carries most of the information in whole length comp data sets
* Dome shaped selectivity messes up a lot of models (often results in conservative OFLs), also changes in selectivity over time
* Important to move forward with more complex models to improve precision (but not necessarily data richness due to cost and resource constraints), also develop simple tools that work well enough for a lot of analysts with less technical skills (add diagnostics and data evaluation)
* Simple methods are temporary expedients, move toward better models with same data
* Analysis of fishery independent surveys of fish in the water yield same results as do analyses of fishery dependent length data (J. Ault)
* Meaghan Bryan’s analysis of queen and redtail snapper is first data poor assessment accepted by SSC and SEDAR
  + Catch history for queen snapper included very early years, so less bias in unfished catch level estimate.
* Caribbean: manage by stock complexes, not stocks – how to provide guidance (Shannon Calay)
  + Find stock within complex that is most sensitive to F, manage for that, protect rest of stocks in complex
* For many stocks, catch reporting is inaccurate (species look alike, lots of sport catch, lots of artisanal catch) would be much easier to use MPAs to control mortality in order to avoid catch accounting. Length-based methods might be good too, because they don’t rely on catch accounting
* Some people have figured out how to impute species specific catch from unsorted catch (Jim Thorson)?
* What are the most important data to gather in data limited fisheries?
* Move away from insistence on B based management to F and effort control (cheaper)

Jason Cope – Extended simple stock synthesis for PFMC groundfish stocks

* Catch only: data poor: dcac, dbsra, SSS (in stock synthesis)
* Catch plus abundance indices: data moderate (Xdbsra, exSSS)
* Catch, abundance index, size and age comp: data rich (SS)
* SS provides common framework for all of these analyses, so fishery can evolve from data poor to data rich
* Did retrospective PSA (before management) to estimate vulnerability
  + Depletion in 1999 higher when vulnerability lower in 1999 (beginning of fishery)
  + Use v scores to estimate depletion at beginning of fishery
* Removed data from SS to see how data poor methods performed
* Using V scores to estimate initial depletion made estimates of spawning biomass better (relative to full assessment)
* Estimates of Bo, terminal B, error improve when V is used to esetimate initial depletion and abundance indices are present (exSSS) vs catch only

EJ Dick - extended depletion based stock reduction

* Bayesian extension of DBSRA

Jim Thorson – catch curve stock reduction analysis

* Used age distribution but could be done with length distribution too
* Can run with just one year of data
* Data poor: just one data stream
* Data moderate: 2 data streams
* Data rich: all 3 data streams

Discussion

* John Hoenig: linear relationship between adult body weight and r for vast range of animals – use as prior for r
* Carl Walters: less than 40% of assessments show dome shaped selectivity
* No stock recruitment relationships support the idea that stocks are productive at high B levels above .5 Bo. Non-stationary recruitment and time lags (fish down big stocks, have to wait for juveniles to become mature for population to grow again). Don’t use surplus production models, do your best with age structured models, look at other sources of variation
* Some sharks and whales might show high productivity at B levels above 0.5 Bo
* Using fixed reference points in a world where productivity changes is shooting yourself in the foot, doomed to fail; need more flexible and adaptive system that uses multiple indicators
* Fmsy is pretty stable across regime shifts, but Bo changes a lot
* Walters: if he had to advise on how to manage complex stocks in Caribbean: let juveniles and big fish escape the gear
* Gulland’s method will always overestimate MSY, causing overfishing
* Schaefer model gets rid of upward biomass but fitting methods biased toward underestimating MSY, wider distribution
* High dimensional stock assessments – chasing noise, less biased on MSY estimation but very wide distributions (higher costs?)

Nick Farmer – generalized approach to indices of abundance

* How to account for trips with zero catch of target? Count effort as trips that land target species AND associated species
* Standardized CPUE trend using MRFSS, headboat, and commercial data was pretty consistent with other indices
* Application to setting ACL – look for time periods with stable or increasing CPUE to get basis for catch-based ACLs – more conservative
* Lots of assumptions but better than just using average catch or highest catch as ACL
* But much of the variation in CPUE trend is probably due to variation in recruitment not changes in production

Alec MacCall

* How much data do we need?
  + If you can block data across areas and times, the blocks may contain sufficient data for an assessment
  + Look at the meta-data, easy to see if an assessment is possible
* Borrow F not abundance from closely related data richer fishery, indicators don’t work
  + Plot cumulative catch of target species against ratio of catch/borrowed F from similar species – linear relationship
* Mine old fish photos to get max size info
* Adaptive management algorithms like An Index Method and slope to target can work
* MPA inside/outside comparisons of densities and length comps provides strong information on F and M, and also substitute for a stock assessment

Jeremy Prince method – length based approach

* Standard curve between weight and contribution of a fish at that weight to SPR (size-fecundity curve) for lots of species with highly varying life history
* These curves fall into categories:
  + Type I m/k greater than 1, clupeidae
  + Type II m/k less than 1, abalones and trachichtyhyidae
  + Type III m/k less than 1 and Lm/Linf greater than 0.85 (whales)
* Generate theoretical unfished distributions of weight to SPR curves
* Compare to fished weight distribution (ratio of fished to unfished)
* Feeds into decision tree; guidance for very data poor to data richer stocks

Discussion

* Catch composition has been reconstructed for single stocks from unsorted catch for Pacific groundfish by looking at location, depth, time of catch and inferring which stock it must have been (Alec)
* Don’t use SPR (Carl Walters) because SPR doesn’t change with recruitment overfishing (due to compensatory dynamics?). Prince method makes contradictory assumptions about SPR
* How do you get a decision rule that pushes fishery toward MSY? Catch plus change in B (productivity); if productivity goes down, reduce catch; if productivity goes up, increase catch.
* If you have only recent catch and historical length records (old photos) may be possible to make assumptions and simulate long time series in order to benefit from the contrast and info from early in the fishery
* Can’t use length-based methods for nearshore fishes due to very different growth rates (Alec MacCall)
* For some populations, fishing moves into new population and fishes them out , then moves on to another population so B and length comp is always “unfished”

DAY TWO

* Tom Carruthers – R based tool that automates many data limited assessment methods, performs simulations, allows for analysis of residuals
* High potential for direct application in US pacific islands, Caribbean, southeast US especially for length-based analyses (Jon Brodziak)
  + Set up local working groups to apply tool, maybe for next year assessment cycle
* High potential for direct application to state fisheries (Sean Powers)
* High potential for application in Pacific (Jason Cope) – side by side comparison of many methods
* Many countries: no length comps, only visual census and sometimes total catch
* Needs more guidance on conditions under which various methods are most appropriate
* Potential application in developing countries:
  + Add method that uses visual census data to generate MPA density ratio, abundance index
  + Output F, M, SPR in addition to OFL so that they can be used as performance indicators in adaptive management
  + Package with training in data evaluation, exploratory statistics and graphing, method selection, interpreting outputs, adaptive management
* User must look at simulation results and residuals to understand which outputs are more plausible than others
* Rank methods based on mean absolute bias?
* MSE to determine whether method is likely to provide bad management advice
* Any avg catch method is vulnerable to shifting baseline and will drive management in wrong direction
* Consequences of choosing various model results – risk
* Set catch limit and leave it for 3 years, then monitor and adjust because methods are not sensitive to annual changes (including length-based methods?)
* Can fill in missing data from unfished blocks with unfished CPUE for sedentary species (spatial analysis)
* Carl Walters – stochastic stock reduction analysis interface very useful in a workshop format with decisionmakers because it clearly shows influence of adding more data to results (status) and also uncertainty is very clearly displayed (in NMFS Toolkit), gets same answers as very complex models (diverges from stock synthesis results, though) – could overestimate allowable catch rates if no age comp data. Requires catch time series PLUS recent absolute biomass estimate

Alec MacCall – Assessments on the Pacific coast

* 90 species, 30 data rich assessments (but half with fixed M and steepness parameters), and 60 unassessed
* 2 ACLs needed for many spp (due to two biogeographic regions under management)
* Needed 100 ACLs by 2011, starting from fall of 2009
* Couldn’t use Walters stochastic stock reduction because no recent biomass estimate available, so invented DBSRA as simpler version
* SSC review and approval, application
* Then post-hoc STAR panel review – first data-moderate STAR
* 2013: 3 more data rich, 2 data rich went into data moderate, 10 dbsra and exSSS, 5 Fmsy/M ratio, 73 data poor dbsra and dcac (interim results), 2 ecosystem components, 11 stocks with catch too low too matter
* Too much faith in assessment models over surveys – good surveys should drive interpretation even if in conflict with model results
* Any model that uses length comp data could be stocks with lots of spatial variation in growth rate (but conversely should be reliable at appropriate scale) - on average (nearshore especially), variation in growth rate across many stocks is about 30% (but couldn’t you interpret results on small scale?)
* Fmsy/M and swept area approaches worked well, respond to changes in abundance – must monitor abundance though – works well especially for lightly fished stocks
* Ecosystem models predict that English and rex soles should be increasing now that the fishery has removed larger flatfishes, and they are
* Instead of using B or Bmsy as reference points (which are hard to know), instead use abundance index and management algorithms
* More distrust by industry of science and government in general in SE region, more attempts to discredit assessments
* West coast industry feels that scientists are not out to get fishery, more accepting of best efforts
* SEDAR more defensive than STAR
* If you have a good abundance survey, use Fmsy/M

Clay Porch – SE regional stock assessment

* Half of all angler trips in US, 6 million anglers
* 20% of commercial US landings
* 300 stocks in FMPS (over 700 exploited), about 100 assessed but frequency is low
* Gulf: Tier 1: Formula to calculate P\* which is used to set ABC from probability distribution of catch and probability of overfishing (OFL)
* Tier 2: if no MSY reference points, use alternative method to estimate PDF of OFL
* Tier 3: no assessment, but stock unlikely to suffer overfishing if future landings remain similar to recent landings (OFL = mean of recent landings plus two SD, but this can result in large OFLs because SDs are very large); ABC = mean recent landings plus a multiple of SD
* 8 ACLs set on data rich assessments, 17 set by Tier 3, 3 set with mean landings
* South Atlantic: 12 data rich ACLs, 32 use 3rd highest landings, 4 use median approach
* MSE analysis suggests that 3rd highest landing ACLs perform very poorly (high risk of overfishing)
* Data: landings, discards, size comp, age comp, cpue, shrimp bycatch, fishery independent size and age comp (for a few stocks) plus relative abundance indices
* But lots of gaps in most of these data sources
* Potential assessments for GMFMC reef fish: 9 data rich (all three criteria met with reasonable quality), 9 data rich/ moderate (one or more of questionable quality, 5 data moderate (one missing or of low quality), 8 data poor (two missing or of low quality)
* Criteria: catch, abundance index, composition
* Potential assessments for SAFMC snapper/grouper: 12 data rich, 19 rich/moderate, 9 moderate, 14 data poor.
* very slow, very thorough, somewhat rigid, planned 2-5 years in advance
* need best practices for data limited approaches to protect against charges of arbitrary and capricious
* Jim Thorson and Jason Cope published analysis of FishBase values (not biased up or down, sometimes wildly imprecise)
* Roadmap
  + This workshop: introduce universe of data limited methods, develop best practices, test automated tools
  + SEDAR procedural workshop
  + Data triage by data providers (characterize and evaluate available data)
  + SEDAR assessment workshops
  + SSC sets ABC with revised control rules
* New control rules:
  + Tier 1 – full assessments
  + Tier 2 – data moderate methods provide MSST, MFMT, and OFL
  + Tier 3 – data poor methods where catch is known, estimate OFL
  + Tier 4 – data poor approaches where catch is unknown that can provide relative stock status
  + Tier 5 – only reliable catch
  + Tier 6 – no reliable data (put in stock complex with similar species that can be assessed)
* Alternatives:
  + Structure tiers based on data availability
* SAFMC: now has a process for accepting new stock assessments from anywhere, for stocks that are not on SEDAR schedule and that the council wants
* GMFMC: set ACLs without SEDAR by using avg catch methods – possible to bring in assessments from outside SEDAR (never meant to be sole source of assessments; meant to tackle very controversial species in a bullet proof way)
* Run first tranche of data limited assessments through SEDAR process to improve buy in and vetting
* Requests by Council for assessment updates when they are unhappy with results or whenever industry presents new information results in delays and big backlog, unassessed/unmanaged stocks
* Also obsession with same two or three stocks prevents assessments of other species
* Paradox: more analyses, more the uncertainty becomes apparent. For data poor stocks right now: avg catch only, no apparent uncertainty, small buffers.

Mark Maunder – Empirical control rules

* One problem is that most of them don’t optimize yield
* Instead of changing harvest if CPUE goes up or down, use surplus production as performance indicators
* Production/catch less than a reference level, increase catch
* P/C in range, keep catch the same
* P/C is less than a reference level, reduce catch
* Take 90 or 90% of surplus production, yield should stabilize at MSY
* If stock is overfished, converge on Bmsy
* If stock is underfished, keeps stock level (precautionary)
* P = B(t+1) – B(t) + C(t)
* B(t) is biomass at start of year t, Ct is catch in year t
* Make sure B estimate is unbiased
* Need catchability

Alec MacCall: Use Yield per Recruit methods, especially to inform size regulations in developing countries

Roadmap for SA and Gulf regions

* Evaluate status quo ACLs (average catch, ORCS) in terms of risk of overfishing and overfished status, costs
* Include worst case scenarios (e.g. variable recruitment) to test robustness of DLM (data limited methods)
* Increase and improve data management capacity
* Data triage (Science Center)
  + Mine data
  + Pull together available data into common format database
  + Allow others to add data
  + Characterize available data (sample size, representativeness, years, portion of species range covered, summary info only or raw data, potential bias)
  + Data tiers: catch, abundance, relative abundance, length comps, M
* Data evaluation and quality control (plotting raw data)
* Method characterizations: data needs, outputs, simulation tested, field tested, ranking
* Decision tree for choosing methods: Reliability of data. Screen methods – discard methods that won’t work with available data, methods that yield consistently poor results. Use DLM tool (Carruthers) to run methods for fishery types to see which might be inappropriate (assumption violations, data gaps, etc).
* Use a single model, or present results from several models? Encourage creativity and exploration (research phase?), seek consensus on meaning of outputs? Or present base model using results of other models to describe sensitivity and uncertainty
* Guidance for using methods, best practices, conditions under which particular methods will provide poor results
* Diagnostics, simulations to evaluate results of data limited methods
* Workshop to run methods, expert judgment for input assumptions, interpretation of results
* Prioritize stocks: landings, PSA, trend in survey abundance, data availability (which stocks are most likely to be assessed successfully with data limited methods?)
* Harvest control rule
  + Use PFMC p\* definition tiers (based on uncertainty)
  + Educate councils about implications of choosing different p\* values (probability of overfishing, probability of generating more overfished stocks and rebuilding plans, costs associated with rebuilding vs short term benefits of higher OFLs)
  + Need higher uncertainty buffers for unassessed stocks
* Use of indicator species?
* Need data limited methods for multispecies complexes
* Each region needs dedicated scientist responsible for getting unassessed stocks assessed
* SA SSC needs to meet more often: big bottleneck
* Need cut-off date for adding new information to assessment