PFRP Pelagic Fisheries Research Program

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Incidental Catches of Fishes by Hawai‘i Longliners

William A. Walsh

A two-year study of incidental catches of several species of fishes by the Hawai‘i-based longline fishery was initiated at the National Marine Fisheries Service (NMFS) Honolulu Laboratory in October 2000 under the sponsorship of the Pelagic Fisheries Research Program (PFRP). The investigators are William Walsh of the University of Hawai‘i Joint Institute for Marine and Atmospheric Research, and Samuel Pooley, chief of Fishery Management and Performance Investigation at the NMFS Honolulu Laboratory.

*All of the species being studied are important ecologically, economically or recreationally, or for some combination of these reasons, but unique problems remain with regard to monitoring and management. The species include blue marlin (*Makaira mazara*), blue shark (*Prionace glauca*), mahimahi (*Coryphaena hippurus*), opah (*Lampris guttatus*), wahoo (*Acanthocybium solandri*), and several pomfrets (*Bramidae*). The project was designed and undertaken to address these problems.*

Three main sources of data are used in this work:

- fishery observers (who were deployed on about 5% of fishing trips made by this fleet from 1994 to 1999, but who now cover about 20%) gather data that summarize catch and operational details such as geographic position, number of hooks, target depth, gear soak time, and type of bait for each longline set (i.e., gear deployment)[1];
- mandatory logbooks submitted to NMFS by commercial longline vessels; and,
- data obtained from the United Fishing Agency fish auction in Honolulu (the principal outlet for the longline catch), which are sometimes used to check on logbooks, observers, or both, especially when fish identifications appear questionable.

Objectives and Methodology

This project has four objectives. The first is to develop a type of statistical simulation known as a generalized additive model

[1]Because the observers are not directly involved in the deployment or retrieval of the longline gear, their data are regarded as appropriate for use in development of standards of comparison for the mandatory logbooks submitted to NMFS by commercial longline vessels.

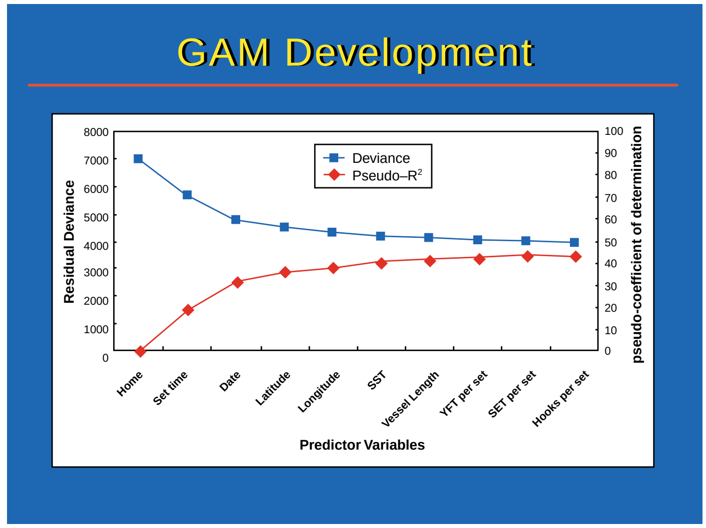

Figure 1. GAM development from observed longline sets from March 1994 through February 2001 (N= 4847 longline sets).

(GAM) of catch rates for each species. Each model will in turn be used to generate corrected fishery-wide catch statistics and to investigate geographic distributions; the final objective is to improve linkages among the three data sources.

The analytical procedures involve fitting the GAMs to the fishery observer data and then applying the coefficients from these models fishery-wide to serve as a sort of “surrogate” observer on the large majority of longline sets that are unobserved. The latter

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means that an expected catch is computed for each longline set, and the expected catch values are used as comparative standards for the logbook reports, with comparisons performed by linear regression and regression diagnostics techniques.

One constraint is that the logbooks do not include nearly as many operational details as the observer data. This requires that pragmatic decisions be made regarding predictor choices to avoid large losses of data because the fitting and application procedures cannot accommodate missing values. Typical predictors include the set latitude and longitude, the number of hooks per set, the date of fishing, and catches per set of co-occurring or target species. It nonetheless has proven possible to develop parsimonious models that yield considerable insight into logbook reporting behavior, a countervailing consideration to the need to limit the number of candidate predictors. Full details of the development and application of a GAM for monitoring blue shark catch rates in this fishery are presented in Walsh and Kleiber (2001) and Walsh et al. (in press).

Species-Specific Considerations

The objectives and methodology described above are subject to important species-specific considerations. One is that the typical level of species abundance in a catch strongly influences logbook reporting behavior and accuracy. For example, blue shark and mahimahi are the predominant species in the incidental catch and can be very numerous on longline sets (e.g. 100 or more); this results in approximation of catch numbers, such that large catches are often logged as multiples of 5, 10, or 25, suggesting that the fish were not individually counted, and introducing a source of error in the logbooks for these species. In addition, these species are often discarded, especially when catches are large, but the logbooks may not document the releases, which represents a form of under-reporting. In contrast, species such as wahoo and opah comprise small fractions of the catch and therefore do not present the challenge of counting large numbers of fish— but because they are not taken on most longline sets, it is difficult to detect under-reporting.

The second general consideration is the economic importance (or lack thereof) of the species in question. Results to date indicate that logbook reporting accuracy tends to be inversely related to economic value; hence, opah, which commands a good price, tend to be reported accurately, whereas blue shark, with negligible value, may be inaccurately reported or not reported at all depending upon the circumstances.

Biological characteristics and inexpert taxonomy are also relevant to these analyses. The pomfrets, for example, actually comprise a complex rather than a single species, but are reported as a single entity because they are quite similar in appearance. As such, it is not possible to clearly define the effects of intrinsic and extrinsic factors on catch rates for individual pomfret species. There is a similar complicating factor in the case of blue marlin: the similarity of the species to striped marlin (Tetrapturus audax) and black marlin (Makaira indica) tends to give rise to accurate reporting of marlins in the aggregate, compromised by inaccurate reporting of individual species.

Blue Marlin: GAM Development and Application

Results obtained to date with blue marlin were presented at the PFRP Principal Investigators' meeting in December. The fitting of a GAM to blue marlin catches per set as reported by fishery observers is summarized in Figure 1. The abscissa presents several environmental and operational factors, arranged left to right according to their order of entry into the GAM. The left ordinate is the residual deviance, and the blue trace represents the deviance reduction achieved with each sequential entry. The right ordinate is the pseudo-coefficient of determination expressed as a percentage, and represents a measure of the explanation of the variation in the response.

The results show that although nine variables yielded significant deviance reductions, catch rates are primarily influenced by the begin-set time, latitude, longitude, date of fishing, and sea surface temperature (SST). It should be noted that begin-set time presumably is a proxy for the type of fishing effort (e.g., tuna- or swordfish-directed) and that the date of fishing probably reflects one or more underlying intra- or interannual process(es) that influence(s) catch rates. In addition, two of the less important predictors were nonetheless significant: catches per set of yellowfin and bigeye tuna, which are both important target species in this fishery.

Figure 2 is a comparison across the seven-year study period of the monthly mean fleet-wide catches of blue marlin (N= 76,588 longline sets) to the mean GAM predictions; the comparison demonstrates that the two were significantly correlated ($r = 0.746$), and therefore that the latter represents a reasonable monitoring tool for blue marlin. However, it was noteworthy that on several occasions, most notably in 1995 and 1999, the logbook reports apparently exceeded the GAM predictions. This suggests that either the GAM failed to describe some important aspect of reality, or that there was bias in the logbook reports. The latter is considered more likely because marlin identification has been an ongoing problem for this fishery (R.Y. Ito, NMFS Fishery Monitoring and Economic Performance Investigation, personal communication). The seven-year logbook and GAM-estimated catch totals (see Table 1) suggest that blue marlin has been over-reported in the logbooks by approximately 21%.

Table 1. Nominal and Predicted Blue Marlin Catches

Logbook reported total blue marlin catch (unobserved sets with complete predictor data)	39,761
GAM estimated total blue marlin catch (unobserved sets with complete predictor data)	32,751
Apparent "over-reporting"	21%

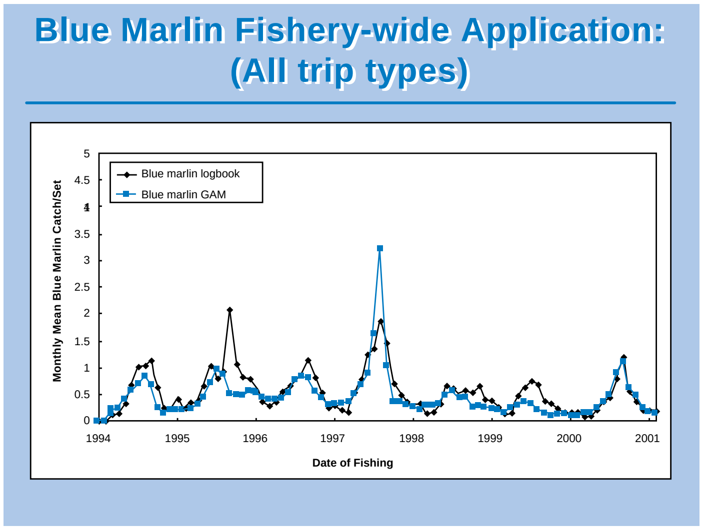

Figure 2. Monthly mean fleet-wide catches of blue marlin throughout the seven-year study period (N = 76,588 longline sets).

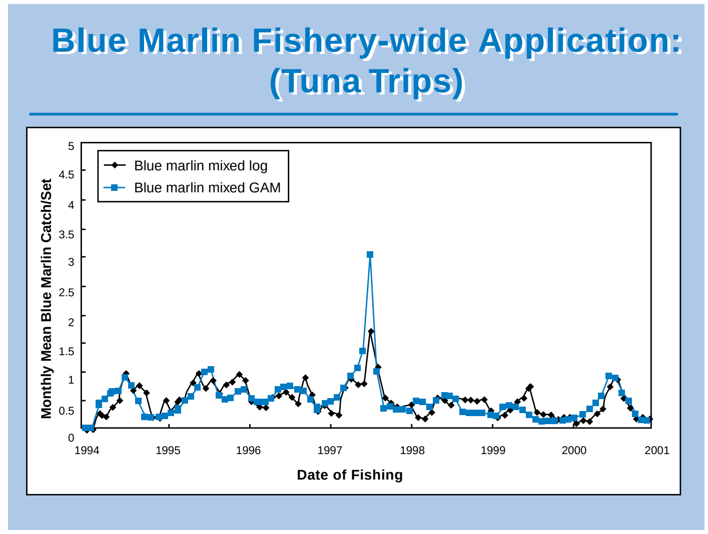

Figure 3. Plots of monthly logbook means and GAM predictions on tuna sets.

The plots of monthly logbook means and GAM predictions on tuna sets (see Figure 3) and mixed-species sets (see Figure 4) reveal that mean catch rates for blue marlin are greater on mixed-species sets than on tuna sets (tuna trips= 0.5 per set; mixed trips= 0.7 per set) and that the GAM and logbook trends are significantly correlated for both types of effort (tuna: r = 0.777; mixed species: r = 0.728). It is also apparent that occurrences of over-reporting tend to be most pronounced on mixed-species trips in the latter part of the year after the annual peak in catch rates has subsided, as shown by the GAM and verified by auction data.

Results from January 2000 to February 2001 are shown in Table 2, and exemplify the improved accuracy attained with these analytical methods. The nominal logbook catch total (3,878 blue marlin) was 6% less than the GAM-estimated total (4,113 blue marlin), which was regarded as unrealistic agreement because prior experience with logbooks prepared in the presence of observers suggested that a negative bias of about 10% represents "optimal" reporting for this species. Applying the aforementioned diagnostic techniques led to deletion of 5.4% of the trips during this 14-month period.

The numbers of fish logged as blue marlin but identified as striped marlin by the United Fishing Agency demonstrated a clear pattern of logbook errors. This indicated that the statistical methods used were detecting real outliers, not simply numerical aberrations. The corrected logbook and GAM-estimated catch totals (i.e., the data from the retained sets) appeared credible, with the caveat that because the deletions were performed conservatively, the logbook totals probably remain inflated to some inestimable extent. The logbook and GAM-estimated trends after deletion of the identified outliers (see Figure 5) are consistent with expectations, with the logbook trace below that of the GAM in every month except at its peak. The next tasks for this species are to perform corrections for blue marlin releases, and for misidentifications of black marlin for this recent period and then back through the logbooks' archive.

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Table 2. Corrections of Blue Marlin Catches: January 2000 – February 2001

Deletions	55 trips (24 mixed; 31 tuna) 21 vessels (10 mixed, 12 tuna)*
Comparison of logbook to UFA regarding deletions	Logbooks: 495 blue marlin; 47 striped marlin UFA: 98 blue marlin; 398 striped marlin
Corrected logbook catch	mixed trips: 702 blue marlin tuna trips: 2,193 blue marlin
GAM predicted catch	mixed trips: 672 blue marlin tuna trips: 3,208 blue marlin
Reporting Errors	Apparent "over-reporting" mixed trips: 4.5% "under-reporting" tuna trips: 32.0% Combined apparent "under-reporting": 25.0%

**the vessel total is less than the sum of its components because one of the boats had both a tuna and a mixed-species trip deleted.*

Incidental Catches of Fishes (continued from page 3)

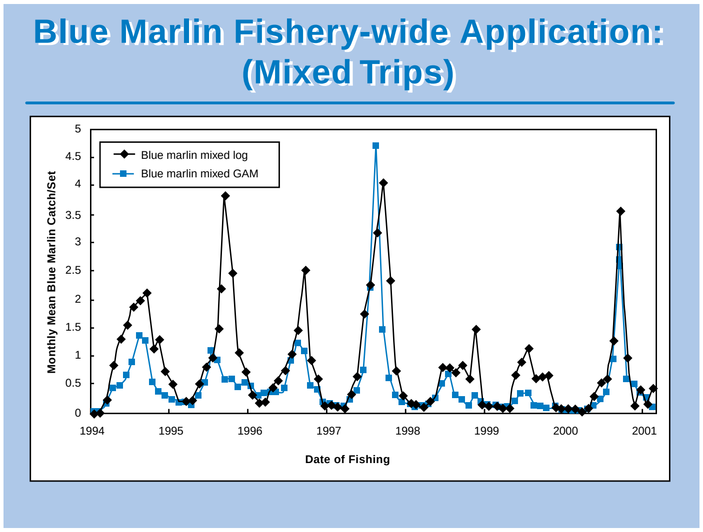

Figure 4. Plots of monthly logbook means and GAM predictions on mixed-species sets.

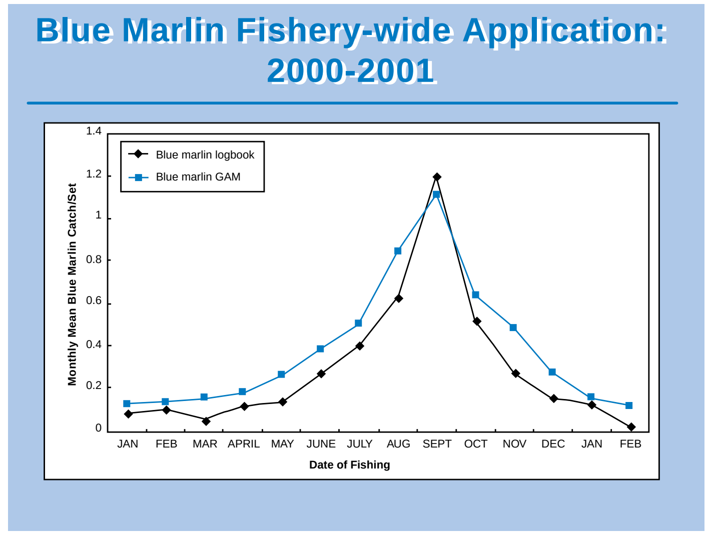

Figure 5. Logbook and GAM-estimated trends after deletion of identified outliers.

Use and Importance of the Blue Marlin Results

Results from this project are expected to be used in other PFRP-sponsored research projects. The blue marlin results are intended for use in a stock assessment to be conducted by Pierre Kleiber of the NMFS Honolulu Laboratory; the corrected catch rates will be used to prepare the most accurate assessment possible.

Blue marlin is the most prized species taken by the charter recreational fishery in Hawai'i, and because it is so important, there is a perception within the recreational sector that the longline fleet takes an excessive number of fish. Results from this project are likely to demonstrate that the longline fleet has in fact taken considerably fewer blue marlin than the official fishery statistics would indicate. As such, the perception of rivalry between these two fishery sectors is exaggerated and to some extent a misperception.

Conclusions

This study has shown that:

- incidental catches of several species of fishes by the Hawai'i-based longline fleet are well suited to analyses with GAM and linear regression methods;
- GAM predictions can serve in lieu of fishery observers on unobserved sets, as indicated by identification of real outliers and errors rather than observations that were simply unusual; and,
- a GAM of blue marlin catch rates included nine significant predictor variables, and its fishery-wide application revealed over-reporting in logbooks relative to time and different sectors of the longline fishery.

The results are expected to prove useful as working material in a stock assessment, and should also document that there is less competition than is widely believed between the longline and charter recreational sectors of the Hawai'i-based fishery.

References

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Walsh, W.A. and P. Kleiber. 2001. Generalized additive model and regression tree analyses of blue shark (Prionace glauca) catch rates by the Hawai'i-based longline fishery. Fisheries Research 53:115-131.

Walsh, W.A., P. Kleiber, and M. McCracken. Comparison of logbook reports of incidental blue shark catch rates by Hawai'i-based longline vessels to fishery observer data by application of a Generalized Additive Model. In press, Fisheries Research.

PFRP

William Walsh is an Assistant Researcher at the University of Hawai'i Joint Institute for Marine and Atmospheric Research, and a Principal Investigator for the PFRP project "Distributions, Histories and Recent Catch Trends with Six Fish Taxa taken as Incidental Catch by the Hawai'i-based Commercial Longline Fishery." His co-investigator on the project is Samuel Pooley, Industry Economist with the NMFS Honolulu Laboratory.

Meetings in 2002

The following meetings of interest to the Standing Committee on Tuna and Billfish were obtained at:
http://www.spc.int /OceanFish/Docs/meetings.pdf.

Date	Meeting Title, Sponsor, Location
Jan 7–9	Expert Consultation on Catch Certification Schemes, FAO, La Jolla, CA
Jan 31–Feb 1	29th Meeting of the International Review Panel, IATTC, La Jolla, CA
Feb 1	9th Meeting of the Permanent Working Group on Tuna Tracking, IATTC, La Jolla, CA
Feb 4–9	8th Meeting of the Working Group on the IATTC Convention, IATTC, La Jolla, CA
Feb TBA	CPUE Modeling/Management Strategy Workshop, CCSBT, Tokyo
Mar 5–6	3rd Meeting of the Bycatch Working Group, IATTC, La Jolla, CA
Mar 7–8	6th Meeting of the Permanent Working Group on Fleet Capacity, IATTC, La Jolla, CA
Mar TBA	Billfish assessment planning meeting, ICCAT, TBA
Apr 29–May 3	3rd Meeting of the Scientific Working Group, IATTC, La Jolla, CA
Apr TBA	GFCM-ICCAT data preparatory meeting, ICCAT, TBA
May 22–24	Third International Conference on Recreational Fishing, Darwin
Jun 18–21	9th Tuna Tracking Working Group, 30th International Review Panel, Meeting of the Parties to the AIDCP, IATTC, Mexico (TBA)
Jun 24	3rd Compliance Working Group/Joint Working Group on Fishing by Non-Parties, IATTC, Mexico (TBA)
Jun 25–28	Annual meeting of the IATTC, IATTC, Mexico (TBA)
Jun–Jul TBA	Age Estimation Workshop, CCSBT, Melbourne
Jul TBA	15th Meeting of the SCTB, SCTB, Honolulu
Jul TBA	Bluefin tuna assessments, ICCAT, TBA
Aug TBA	Stock Assessment Meeting, CCSBT, Canberra
Sep TBA	Swordfish assessments, ICCAT, TBA
Oct TBA	Scientific Committee, CCSBT, Canberra
Oct TBA	Bigeye assessment, ICCAT, TBA
Oct TBA	Standing Committee on Research and Statistics, ICCAT, TBA
Nov TBA	Annual Meeting of the CCSBT, CCSBT, Canberra
Oct 28–Nov 4	Commission Meeting, ICCAT, TBA

Upcoming Events

February 11–15, 2002

2002 Ocean Sciences Meeting, Honolulu, Hawai'i

Convened by the American Geophysical Union and the American Society of Limnology and Oceanography, and described as "one of the best meetings for interactions between biological and physical oceanographers." Details and on-line registration at https://jupiter.agu.org/os02rgels. html. Preregistration deadline is January 11, 2002; after January 21, individuals must register on-site.

February 21–March 1, 2002

Preparatory Conference for the Establishment of the MHLC Commission (PrepCon 2)

The second session of the PrepCon 2 will take place in Papua New Guinea from February 21 to March 1, 2002. Proposed schedule: Informal consultations Feb. 21–22 at Madang Resort, Madang; retreat for delegation leaders on Feb. 23–24 (location TBA); PrepCon 2 from February 25 to March 1 at Madang Resort. Additional details at:

http://www.ocean-affairs.com/prepcon2.html.

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