On diver catch-per-unit-effort series as measures of the relative abundance of queen conch and their use in stock assessments for the islands of Puerto Rico and Saint Croix[1]

by

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Several previous assessments of the status of queen conch populations in the U.S. Virgin Islands, Puerto Rico and other locations have relied heavily on the results from surplus production models (Anon. 1999, Valle 2002). Such models require as input at least one series of yield and one index of stock abundance or effort for tuning purposes. Nominal or standardized catch-per-unit-effort (CPUE) series are the most commonly used fishery dependent indices of stock abundance. However, the use of CPUE for this purpose requires careful selection of the 'unit-of-effort', so that an increment in effort results in a proportional increase in catch. This paper suggests that the diver-based CPUE data available for queen conch do not meet this condition, and therefore should not be considered an index of population abundance.

The majority of queen conch landings in the U.S. Virgin Islands and Puerto Rico (about 97%) are made by SCUBA divers. During the SEDAR process, participants familiar with the operation of this fishery revealed that conch divers generally search for

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aggregations of queen conch and afterwards don the SCUBA gear to harvest them. Typically, the divers are working in about one hundred feet of water and spend less than an hour and a half actually harvesting the conch (owing to bottom time limitations associated with breathing air at depths). Once a conch aggregation is found, it can easily be relocated on subsequent days owing to the limited mobility of queen conch. Moreover, when the density of the aggregation is sufficiently reduced, the divers will abandon it and search for a new aggregation.

The units of effort that were available for constructing diver-based CPUE series were trip and number of hours spent fishing. Unfortunately, no information is available on the time spent searching for an aggregation or whether the aggregation that was being fished had been located during an earlier expedition. A CPUE series constructed from these data would therefore be, at best, an index of aggregation density rather than the overall abundance of the stock. Even in this regard, however, such an index would be found wanting because divers can modulate their encounter rate by swimming or drifting at different speeds (thus, the rate at which divers can pick up conch is not directly proportional to local density). For these reasons, one would expect divers to be able to catch similar numbers of conch over a fairly wide range of abundance, with substantial declines in CPUE perhaps becoming evident only when the stock has been reduced to very low levels. Other difficulties in interpretation may also arise owing to the multispecies nature of the fishery, since divers often spearfish and hunt lobster on the same trip and may change their behavior in response to local conch densities.

Some empirical evidence supporting the above expectation that CPUE does not track abundance very well can be found in comparisons of the standardized CPUE with the landings. Figure 1 shows the estimated total queen conch landings and standardized catch per trip (i.e., CPUE using ‘trip’ as the unit-of-effort) for the island of St. Croix. Figure 2 shows an alternative CPUE series, based on reported ‘hours fished’ (available from 1996 onwards). As can be seen in the figures, the landings of Queen conch in St. Croix increased eight-fold from 1992 through 2006 from about 29,500 lbs. to about

237,000 lbs. Nevertheless, the CPUE during this period, and in fact over the entire time series, remained relatively constant

The results were similar for the island of Puerto Rico. Figure 3 shows the estimated total landings and standardized catch per trip Figure 4 compares the estimated CPUE series for Puerto Rico using both 'trips' and 'hours fished' as units of effort (information on the number of hours fished was not collected in Puerto Rico until 1999). With the exception of the last two years, the CPUE series do not show a discernible trend. Of particular interest are the estimates for the years between 1989 and 1992, which have been described by the queen conch commercial sector in Puerto Rico as especially poor due to low abundance of the stock (as reflected by the comparatively lower catches). As expected, the estimated CPUE values during that period (1989-1992) differ little from the values estimated for earlier or later years because they only reflect the ability of divers to pick up conch once they have found an aggregations, not the overall abundance of the resource. Similar problems regarding queen conch CPUE were found in other fisheries throughout the region (Anon. 1999).

Assuming that a CPUE series is an index of abundance when it is not can lead to seriously false conclusions. For example, in a surplus production model framework, an increase in landings of 8 fold (like the case of St. Croix) and a constant CPUE during the same period of time (presumably indicating constant stock biomass) can only be explained by the model as the result of observed landings being well below MSY and therefore not affecting abundance. Preliminary runs of the logistic surplus production model also indicated that the stock was severely overfished during the early part of the time series (Figure 5), albeit with considerable uncertainty. The only way both conditions could be true (overfished in the 1980s, but catches observed since far below estimated MSY) is if catches in the past were several times larger than current catches. This seems very unlikely given anecdotal accounts of the history of the fishery.

In addition to the likely biases associated with the diver-based CPUE, there are also uncertainties associated to the estimated landings. Because in many occasions some fisher did not submit landing reports, expansion factors were used to raise the reported

landings to account for incomplete reporting. It has also been established that in the Island of Puerto Rico there were instances when the landings reported by individual fishermen differed from what was actually landed (Matos-Caraballo, 2004). For both islands, there is also a lack of estimates of recreational harvests. The only estimate available corresponds to the island of Puerto Rico where recreational harvest was estimated to be 35% of the commercial in 1986. Hence, queen conch harvest by the recreational sector is potentially important.

Given these difficulties, it would not seem prudent to continue to assess conch stocks in the U.S. Virgin Islands and Puerto Rico by use of a production model that depends on diver-based CPUE series. The development of fishery independent indices of abundance should be made a priority for the region.

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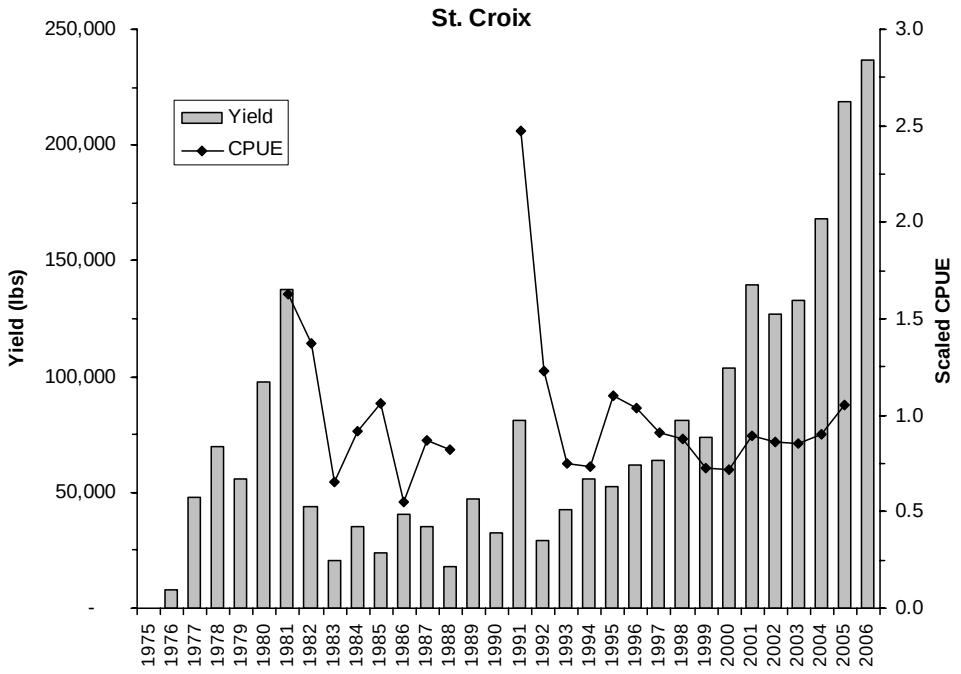

Figure 1: Estimated total yield and standardized CPUE, estimated using 'trip' as unit-of-effort for queen conch for the island of St. Croix.

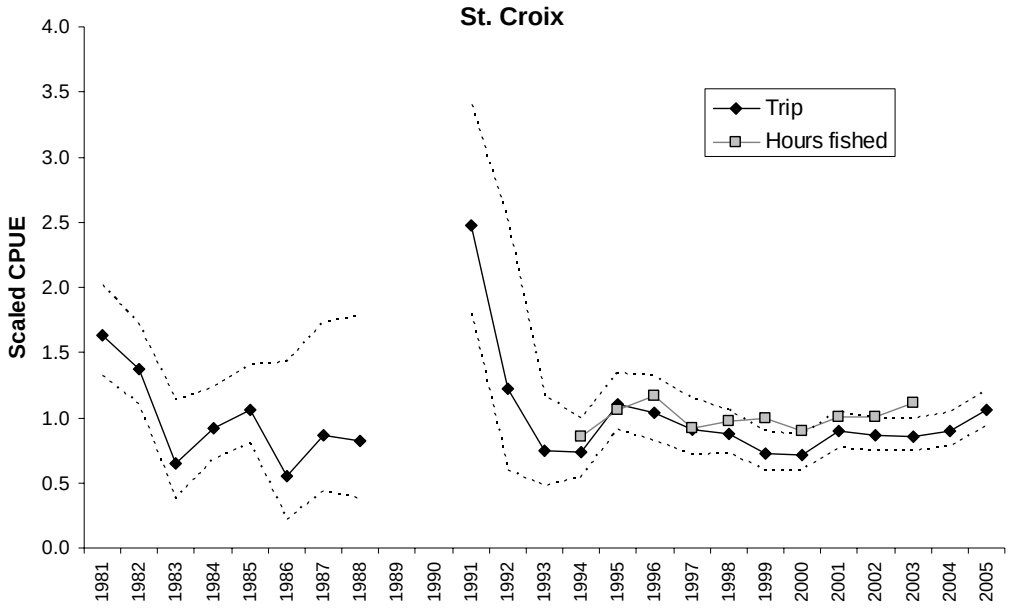

Figure 2: Estimated CPUE series for queen conch using 'trip' and 'hours fished' as unit of effort for the island of St. Croix. For comparison purposes, both series were scaled to their respective overall means. Dashed lines correspond to 95% CI.

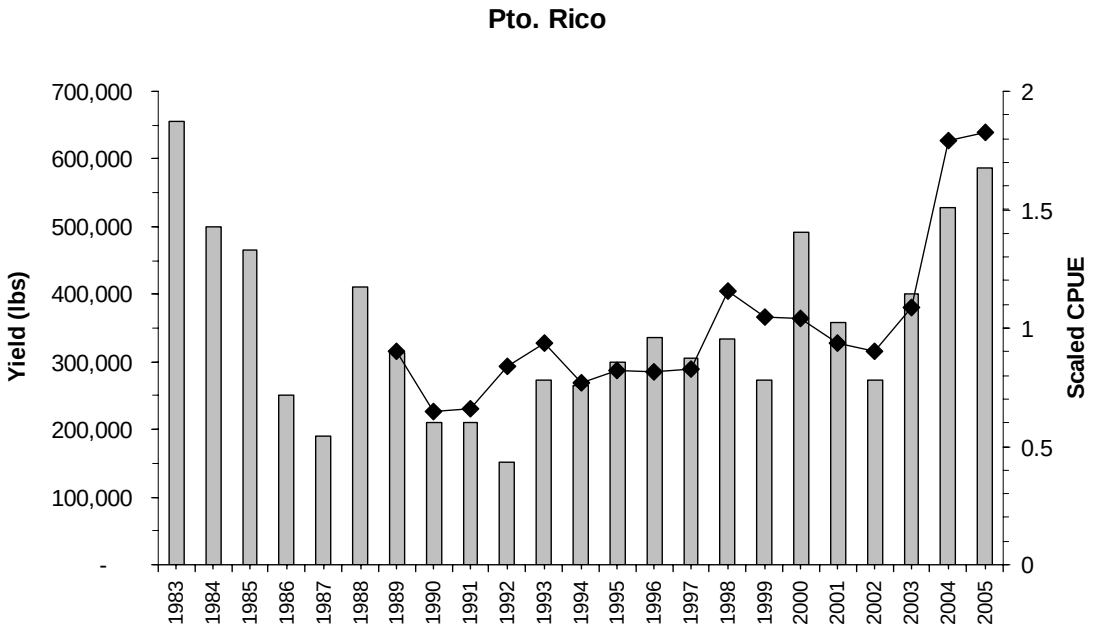

Figure 3: Estimated total yield and standardized CPUE, estimated using 'trip' as unit-of-effort, for queen conch for the island of Puerto. Rico

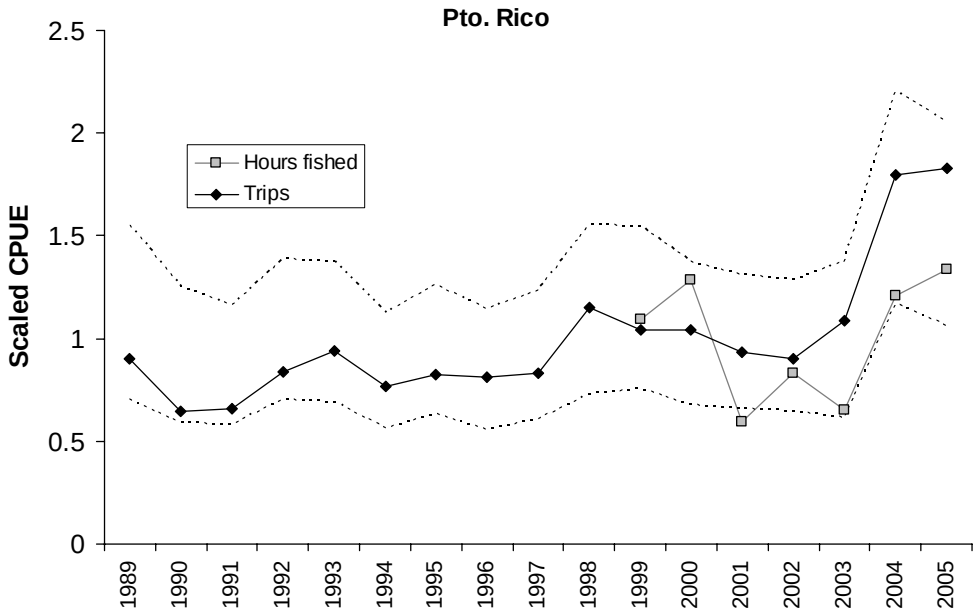

Figure 4: Estimated CPUE series for queen conch using 'trip' and 'hours fished' as unit of effort for the island of Puerto Rico. For comparison purposes, both series were scaled to their respective overall means. Dashed lines correspond to 95% CI.

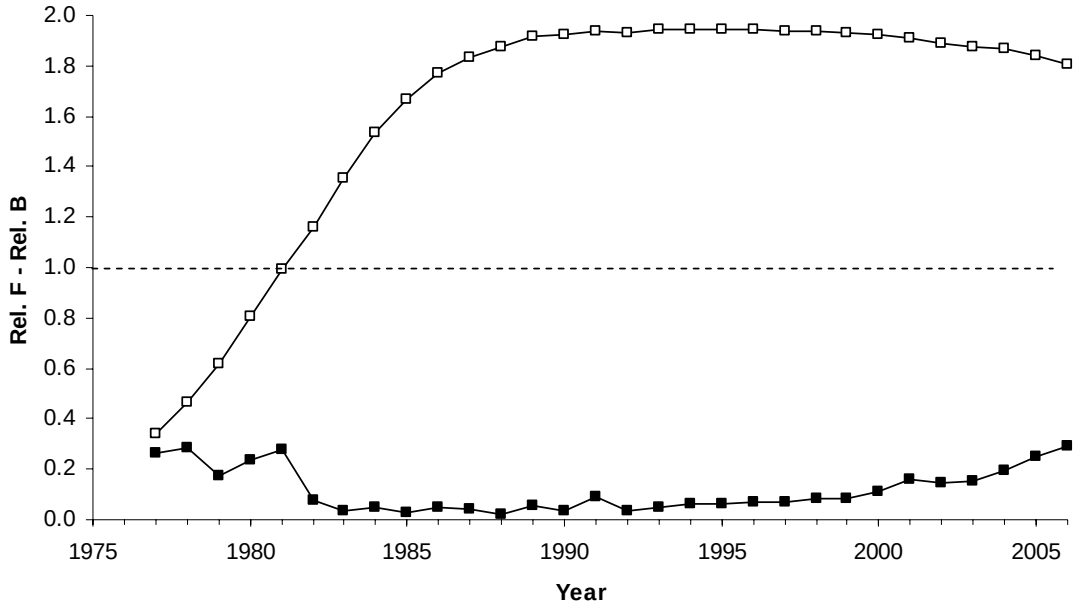

Figure 5: Results of preliminary production model runs (ASPIC) showing relative biomass B/B_{MSY} (white squares) and relative fishing mortality rate F/F_{MSY} (black squares) trajectories for the island of St. Croix.