Pollock Conservation Cooperative January 20, 2009

The Undercatch Incentive Program:
A Chinook Salmon Bycatch Reduction Program for Pollock Catcher-Processors

Description

The undercatch incentive program (UIP) was developed during 2008 by personnel from Trident Seafoods Corporation. In essence, the UIP creates an annual bycatch competition. To create an incentive to reduce Chinook salmon bycatch, the program establishes a bycatch incentive fund (BIF) via the collection of a levy from each competitor (fishing vessel, company) on each ton of pollock catch. Thus, each competitor contributes to the BIF in proportion to its pollock catch. The program then awards the incentive fund back to the competitors according to relative salmon bycatch performance. In the UIP, relative bycatch performance is determined with respect to the worst performing competitor.

Bycatch Results Measurement

The UIP makes use of two measures of bycatch results. The first, termed the Bycatch Ratio, is an industry-standard benchmark and is measured as the number of salmon per 100 tons of pollock catch. By convention, and to associate poor performance with a low index number, the negative of the bycatch ratio is used to describe bycatch results. Thus, the bycatch ratio is limited "on the right" by zero and "on the left" by about negative ten. The second measure, termed Bycatch Performance, is specified as tons of pollock harvested per each Chinook salmon in the bycatch. Bycatch performance is adopted as a sector-wide measure of salmon bycatch results. In general, good bycatch performance, especially by the catcher-processor sector and fishery-wide, is associated with low salmon encounters (abundance on the pollock grounds). For example, Pollock Conservation Cooperative (PCC) bycatch performance for 2008, at about 75 tons per salmon, illustrates these circumstances.

In the UIP, competitor relative bycatch performance is measured as Undercatch. Competitor undercatch is calculated by subtracting the minimum of the negative bycatch ratios of all the competitors from the negative bycatch ratio of the competitor of interest, and then multiplying this result by the amount of pollock catch of the competitor in units of 100 tons, e.g.,

$$U_i = ((-n_i/p_i/100) - \min(-n_i/p_i/100))*(p_i/100)$$

where U_i is the undercatch of competitor i, n_i is number of salmon in the bycatch, and p_i is tons of pollock catch.

Bycatch Incentive Award Payments

The UIP provides rewards for undercatch, which is a proxy for avoided salmon bycatch. To accomplish this, the UIP awards the BIF to the competitors in proportion to their estimated undercatch. Because the undercatch of the worst performing competitor is zero, this competitor does not receive an incentive payment.

Additional (Vessel-Level) Incentive for Very Low Bycatch Performance

According to the constructs of the UIP so far described, the worst performing vessel automatically loses its entire BIF contribution, but no more. As such, it is possible for the worst performing vessel to incur increased salmon bycatch without further consequence. To address this aspect of the UIP, an additional incentive is placed on the worst performing vessel where circumstances warrant. Specifically, for each company, another company must own the vessel referenced as its worst competitor. This encourages a vessel that believes it may be the worst competitor to improve performance because the magnitude of its incentive is no longer limited by its BIF contribution.

Additional Incentive for Ultra-High Bycatch Performance

As noted above, high bycatch performance by the entire catcher-processor sector is likely associated with low encounters. In these circumstances, relative bycatch performance can become more a consequence of random changes in the distribution of salmon on the grounds and less a consequence of competitor fishing behavior. As such, as encounters decrease, a point is eventually reached where relative bycatch results are no longer under the control of the vessel. In practical terms, the UIP gradually changes from an incentive plan to reduce salmon bycatch to a program of fines for random salmon bycatch.

To address these circumstances, an incentive for ultra-high bycatch performance conditions is added to the UIP. To maximize the value of this incentive, it must be placed at a performance level where the transition from viable incentive program to a program of bycatch fines is complete. The incentive consists of two conditions, each of which must be met concurrently, and in which case the UIP settlement payments are suspended. The first condition is that sector-wide bycatch performance must exceed a relatively large amount, say 50 tons per salmon. The second condition is that the distribution of competitor negative bycatch performance must not exhibit excessive negative skewness.

Nature of Awards and Penalties for Bycatch Performance

The UIP provides financial awards for good relative bycatch performance. The program first requires that the competitors create a BIF via a per-ton levy on total pollock catches. The BIF amount depends on the size of the levy and the eastern Bering Sea pollock total allowable catch, and is expected to range between $4 million and $8 million for the catcher-processor sector. The UIP then determines competitor bycatch incentive payments based on relative bycatch performance. Specifically, competitor relative bycatch performance determines the fraction of the BIF contribution that is returned to the competitor. Adding together the negative BIF contribution and the bycatch incentive payment yields a net financial result due to the UIP. In the extreme, the reward for salmon bycatch avoidance is a bycatch incentive payment greater than the BIF contribution. In most cases, the maximum penalty for failure to avoid salmon bycatch is forfeiture of the entire BIF contribution. However, where circumstances warrant, a supplemental levy amount increases the financial penalty.

The incentive to avoid salmon bycatch provided by the UIP increases as the size of the pollock TAC increases and-or the size of the per-ton levy increases. Also, due to the mathematical structure of the UIP, the magnitude of the incentive to avoid salmon bycatch increases as the total amount of undercatch decreases. From examination of the formula for undercatch, it may be observed that the estimated undercatch becomes smaller as the spread in the relative bycatch performances of the competitors shrinks. As such, as the range of competitor bycatch results becomes narrower, the magnitude of the incentive to avoid salmon increases. A relative index of the magnitude of the incentive to avoid salmon bycatch may be obtained by dividing the BIF amount by the estimated undercatch.

Incentives to Avoid Bycatch for All Conditions of Pollock and Salmon Abundance

The UIP provides a financial incentive to avoid salmon under all conditions of salmon and pollock abundance. As noted, the magnitude of the incentive to avoid salmon bycatch increases as the size of the pollock TAC increases and-or the size of the per-ton levy increases. As such, any given level of UIP incentive can be maintained under different conditions of pollock abundance simply by adjusting the levy amount.

The UIP addresses the requirement for maintaining incentives to avoid salmon bycatch at all levels of salmon encounters in several inter-related ways. First, the magnitude of the incentive can be set to address any anticipated level of encounters via selection of the levy amount. As noted above, should differences in competitor performance narrow due to increased efforts to avoid salmon bycatch, then the mathematical structure of the UIP works to automatically increase the incentive per avoided salmon. This is accomplished because under these conditions the estimated undercatch will decrease, thus pushing up the magnitude of the incentive, and so encouraging further efforts to avoid salmon bycatch.

Second, the incentive for ultra-high bycatch performance supplies a large financial incentive at a point where the capability of the competitors to avoid salmon bycatch begins to disappear. As noted, these circumstances occur when salmon encounters are low, and when avoiding additional salmon bycatch may be especially valuable for salmon conservation efforts. The maximum benefit of this incentive is achieved when it is placed at a performance level that can be reached via "a stretch to the limit." That is to say, it is placed at a level high enough such that the competitors can't easily exploit it, but yet a level low enough such that there is some chance it can be achieved. When set at this point, the incentive should provide strong motivation for the competitors to develop and embody new technologies to avoid salmon bycatch at lower levels of salmon encounters. Such an incentive should then over time push lower the level of encounters at which the capability of the competitors to avoid salmon disappears.

Further Reading

An analysis of a vessel-level UIP competition has been provided as "Analysis of an Incentive-Based Chinook Salmon Bycatch Avoidance Proposal for the Eastern Bering Sea Pollock Fishery," by Levis A. Kochin, Christopher C. Riley, Ana Kujundzic, and Joseph T. Plesha. The analysis was presented at a public workshop on salmon bycatch management hosted by the North Pacific Fishery Management Council in Anchorage, Alaska on December 9, 2008, and is available from the authors.

lot. A dot representing each interval in the table is placed *over the middle* ›f the interval at a height corresponding to the appropriate point on the requency axis, and the dots are then connected with a line.

Frequency polygons are easier to draw than histograms, and they offer he added advantage of allowing several polygons to be placed on the ;ame pair of axes. Examples of this are shown in Figures 2.5 and 2.6.

hape of the Distribution

Since the frequency distribution graph contains no more and no less nformation than the table it was made from, you may still be wondering f it is really worthwhile to go to the trouble of making a graph when a able might do. While it is technically true that the information contents of the graph and table for the same data are identical, it is usually easier for the reader to extract certain kinds of information from the graph.

Remember that you are probably using statistics to examine the way a variable is distributed among a group of observations. You may be nterested in finding the typical group member, the range of observed values, or the extent to which different score values differ in frequency. These characteristics may be estimated from either the table or graph, although most people probably find graphs easier to use for these purposes. In addition, graphs are especially useful for evaluating two other characteristics of distributions: **skew** and **kurtosis.**

Skew is a term used to describe the extent to which a distribution deviates from symmetry. All distributions are either skewed or symmetric, and two varieties of each kind are shown in Figure 2.4. These are frequency polygons that might represent observations on any variable. Figures 2.4(a) and 2.4(b) are **symmetrical** distributions because the left half of the polygon is a mirror image of its right half. Figures 2.4(c) and 2.4(d) are **skewed** distributions because the right half of each figure is not a mirror image of its left half.

Suppose that Figure 2.4(c) is a frequency polygon showing test scores registered by a large class of students on an introductory statistics exam. Test-score values would be arranged along the horizontal axis, and the vertical axis would scale the observed frequencies. You can tell from the figure that a relatively large number of people got low scores on the test and few people scored high. When many people score low and only a few score high, the resulting distribution is said to be **positively skewed.** If just the opposite happens, that is, if many score high and a few score low, then the distribution is **negatively skewed.** To many, these designations of positive and negative seem just backwards from the way they should be, since a positive skew means a high number of low values. But remember that the *tail* of the distribution, the part with low frequencies, points in the direction of the skew. A negatively skewed distribution like that in Figure 2.4(d) has a tail pointing in the negative direction

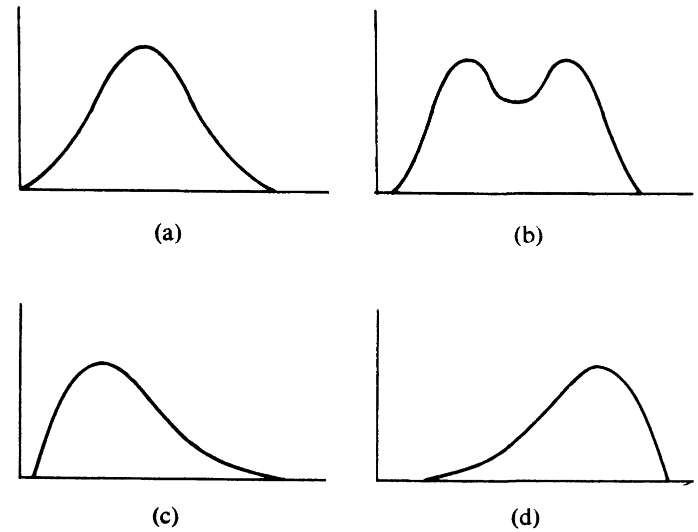

Figure 2.4. Symmetric and skewed frequency distributions. In each distribution the vertical axis represents frequencies obtained and the horizontal axis represents values of the variable or event categories observed. Examples (a) and (b) are symmetrical distributions because the left half of each is a mirror image of its right half. Distribution (c) is positively skewed, the kind of distribution that might be produced by scores from a difficult examination. An easy examination might produce a negatively skewed distribution, such as (d).

The presence of skew in a distribution can sometimes be an important item of information. A distribution of performance scores skewed positively means that the task was difficult for the group as a whole, and a negatively skewed distribution means that the test was probably easy for the group.

Consider the frequency polygon that might appear if we graphed annual incomes of U.S. citizens. Different income values would be represented on the horizontal axis, and the vertical axis would represent the frequency with which these values occur in the population. Which graph —2.4(c) or 2.4(d)—would more likely be the result? The income axis would cover a range of dollar values extending from zero through many millions. Most observations would tend to fall near the low end of the distribution, meaning that we could describe the distribution of annual incomes as positively skewed.

The frequency polygon for IQ scores in Figure 2.3, on the other hand, is nearly symmetrical. By indicating that the distribution is not skewed, we say that there are just about as many high IQs in the group as there