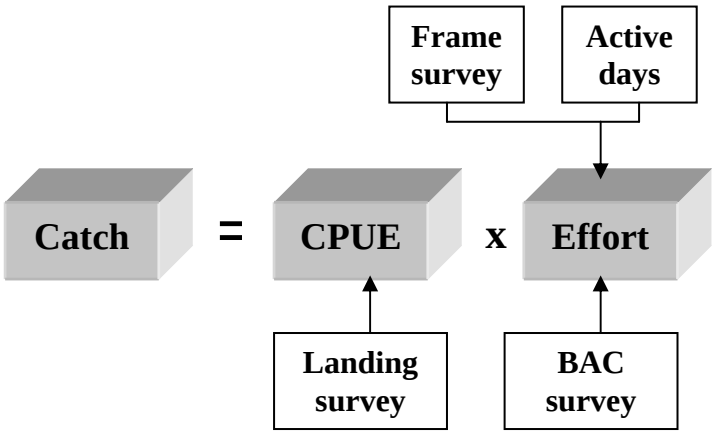
2. Concepts in estimating catch and effort

In this section readers will be presented with a generic approach for estimating total catch from basic fishery data and within an estimating context of a geographical stratum, a reference period and a specific boat/gear category. Other secondary data such as catch by species, values and average fish size, are estimated at a secondary stage and on the basis of the estimated total catch.

No complete enumeration (i.e. census) approaches for determining total catch are discussed in this handbook. In most small-scale fisheries the amount of information regarding total landings, species composition, prices, etc., is so large that the use of census approaches is impractical and sampling techniques are almost invariably employed.

2.1 A generic formula for estimating catch

The generic expression given below describes the relationship between *estimated* catch, *sample* CPUE and *estimated* effort.



A brief description of the variables involved is given below.

2.1.1 Catch (total)

Estimated total catch refers to all species taken together and is usually computed within the logical context of:

(a) A limited geographical area or stratum.
(b) A given reference period (i.e. a calendar month).
(c) A specific boat/gear category.

2.1.2 CPUE (sample, overall)

The sample Catch-Per-Unit-Effort (CPUE) is an *overall* average deriving from sampling and expressing how much fish (all species) is caught by a unit effort. Sampling context is the same as that for the estimated catch.

2.1.3 Effort

BAC (= Boat Activity Coefficient) expresses the probability that any boat (in general a fishing unit), is active (i.e. fishing) on any active day during the survey period.

2.1.4 Number of boats (from frame surveys)

This is a spatial extrapolating factor and relates to the total number of boats that are potentially operating in the geographical area of the estimation context. It is usually recorded by frame surveys conducted at relatively large time intervals. When multiplied by BAC it specifies the total number of fishing units that are expected to be active on any day of the survey period.

2.1.5 Active days

This is a time-extrapolation factor and specifies the total number of days that are assumed to be normal fishing days during the survey period. It is usually formulated by first considering the total number of calendar days and then reducing it according to empirically known factors, such as holidays, weekends, bad weather, etc.

This number accounts uniformly for days of normal activity, whereas the probability BAC accounts for individual variability of fishing activity.

2.1.6 Numerical example

The following theoretical example uses the formulae given above and illustrates a stepwise process for deriving primary estimates for catch and effort.

A. Assumptions

(a) Estimating context: *Lake Volta, Area VII, February 2001, Gillnets*
(b) Number of boats in Area VII (from frame survey): 2 000.
(c) Active days: 20.
(d) During February 2001 a total of 50 landings were sampled amounting to 500 kg and corresponding to 50 one-day fishing trips.
(e) During the same month a total of 100 canoes were examined for daily activities and 80 were found active (i.e. fishing).

B. Estimations

(f) From sample (e) we deduce that the probability BAC is 0.8, computed as the proportion of the number of canoes that were found active (80) over the total number of canoes sampled (100).
(g) This probability is then multiplied by 2000 to find the expected number of canoes that are active on any day. The result is 1600. Finally this number is multiplied by 20 in order to obtain total

number of fishing days. We thus find that fishing effort is estimated at 32 000 fishing days (or canoe days).

(h) From sample (d) we find that the mean CPUE is 500 kg divided by an associated effort of 50 days, i.e. CPUE = 10 kg day^{-1}.

(i) Finally, by applying the generic formula for estimating total catch, we multiply the estimated CPUE by the estimated effort and obtain a total of 320 000 kg.

2.2 Target populations and their distributions

Were it possible to know all landings made by a fleet during a survey reference period, then the distribution of these landings would correspond to one of the following three categories.

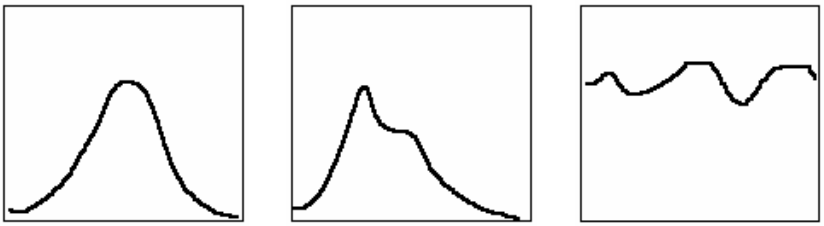


Figure 2.1. Normal, skewed and flat distributions of landings

In some cases the distribution of landings is normal (or close to normal), but this is not always possible to verify. In most cases landings follow an asymmetrical distribution (second plot), whereas flat (rectangular) shapes are at times observed with small pelagics.

However, the overall shape of the distributions of landings is “convex”, that is the frequency (or population density) increases near the mean and decreases near the boundaries or all values between and

including the population boundaries have approximately the same frequency.

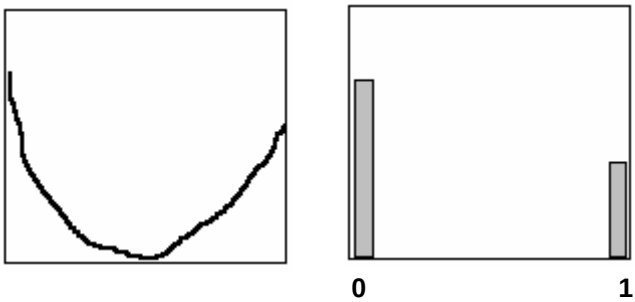


Figure 2.2. General shape of concave distributions and the specific case of 0-1 distributions describing boat activities.

In contrast to convex populations, the density of a “concave” population increases near the boundaries and decreases near the mean. The described set of boat activities is a specific case of a concave population with all of its values being equal to the boundaries 0 and 1 at varying proportions.

The observations made above on the two major categories of populations (convex and concave) will have a direct impact to the precautionary approaches in sampling operations and the manner in which *a priori* accuracy indicators will be handled.

SUMMARY

At this point readers should be familiar with the parameters involved in the estimation of CPUE, fishing effort and total catch. The following points have been emphasized:

(a) All estimations are performed within a specific logical context of a stratum, a reference period and a boat/gear category.
(b) Within each context, estimates of total catch are derived from a generic formula involving CPUE and fishing effort.
(c) CPUE estimates are derived from samples of catches (landings) combined with associated fishing effort.
(d) Estimation of effort is based on sample BACs (boat activity coefficients) that are raised to total effort by using spatial and in-time extrapolating factors.
(e) The population of landings is assumed to be “convex” that is with population density higher near the mean and thinning out near the boundaries.
(f) BACs are estimated through sampling from a population of 0-1 elements corresponding to non-fishing and fishing boats. This is a specific case of a “concave” population whose density is higher near the boundaries and thin around the mean.
(g) Categorization of populations into convex and concave will have a direct impact to the sampling approaches that will be described in the coming sections.