Fish Population Dynamics

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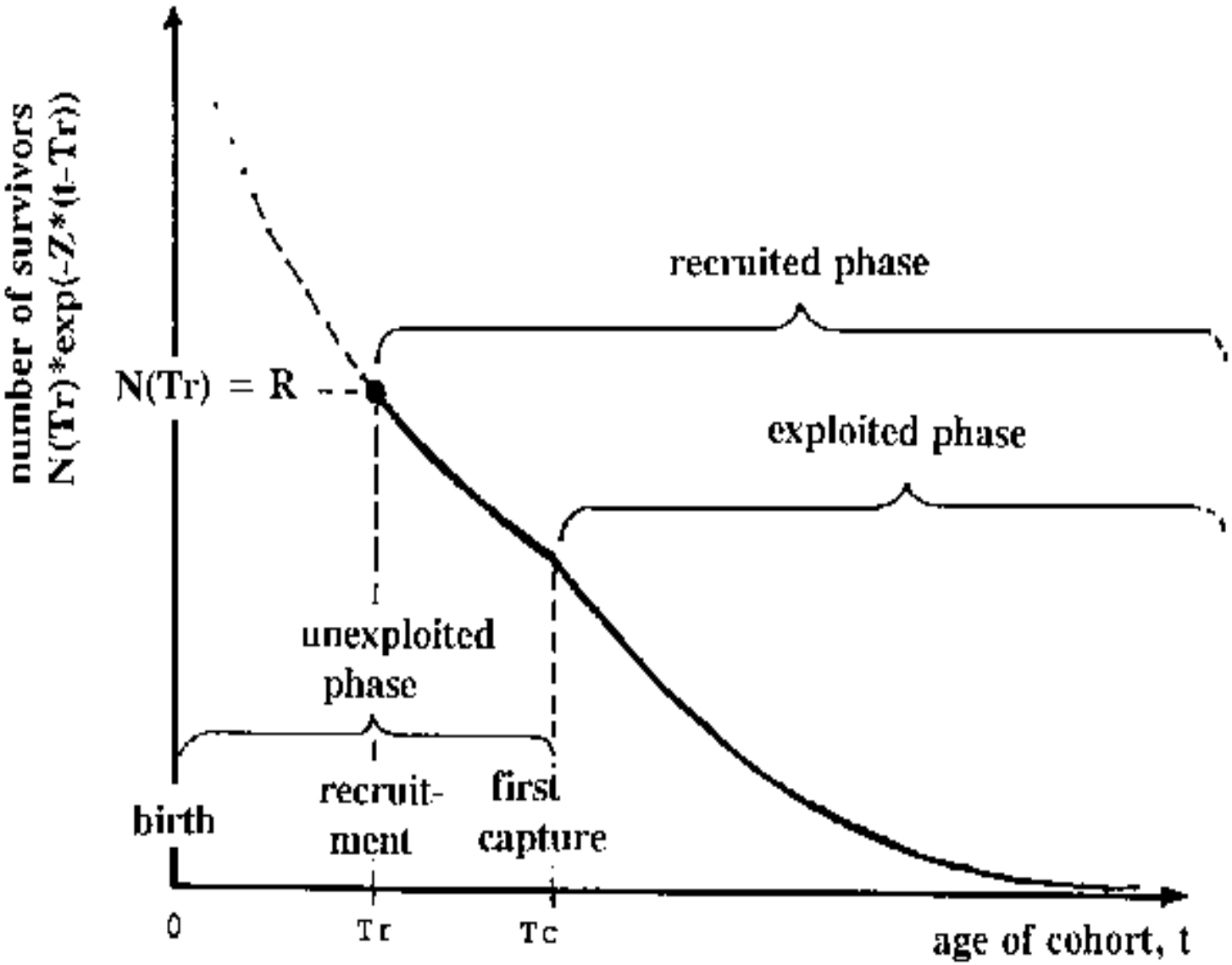
ESTIMATION OF MORTALITY RATES

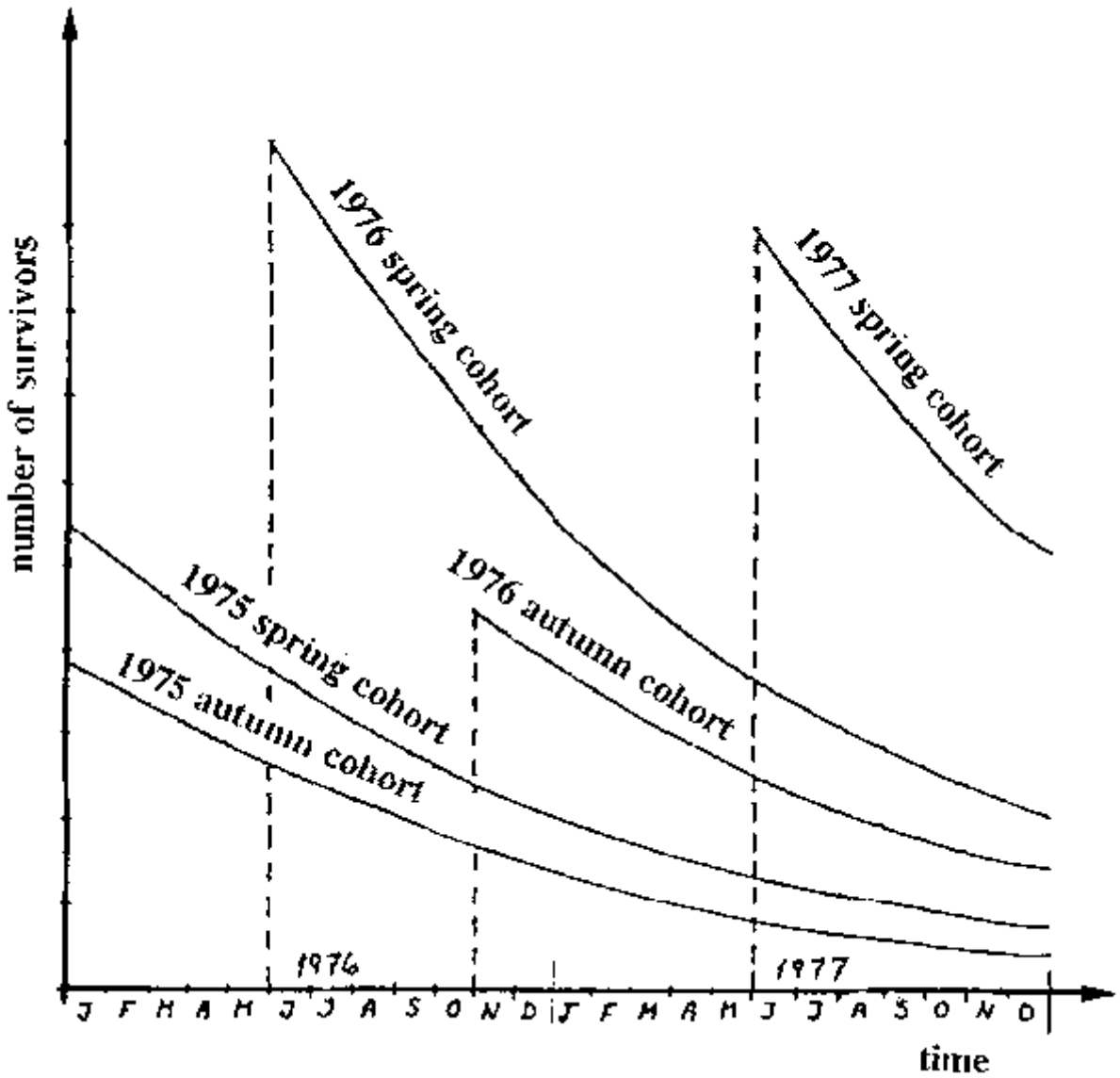
- The easiest way to describe the change in numbers in a fish stock is often to follow the fate of fish spawned at approximately the same time, a cohort. We shall consider the mortality of a cohort as composed of the mortality caused by fishing and that due to all other causes lumped together as the "*natural mortality*". The latter covers events such as predation, disease and deaths due to old age.

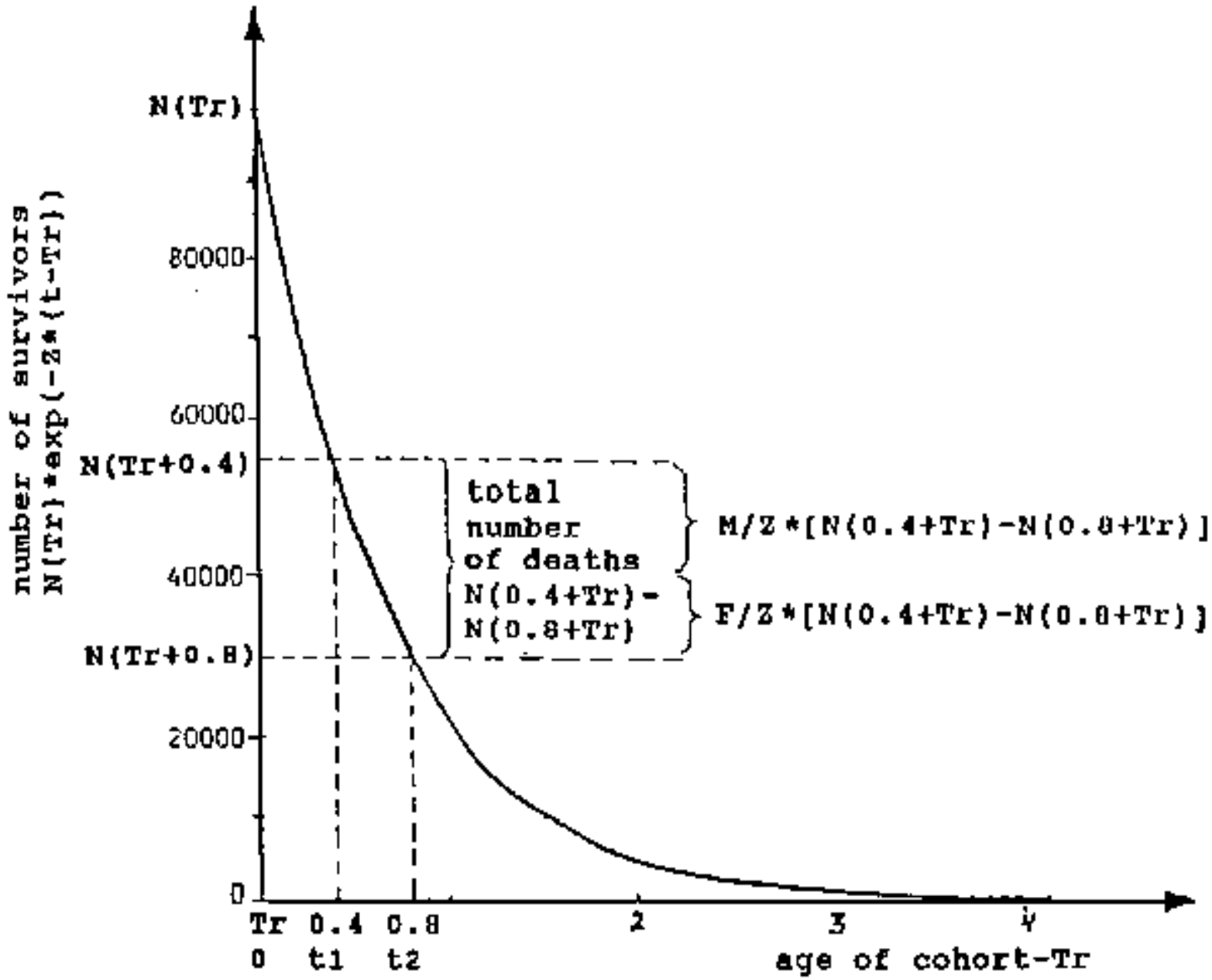
THE CONCEPT OF A COHORT AND SOME BASIC NOTATION

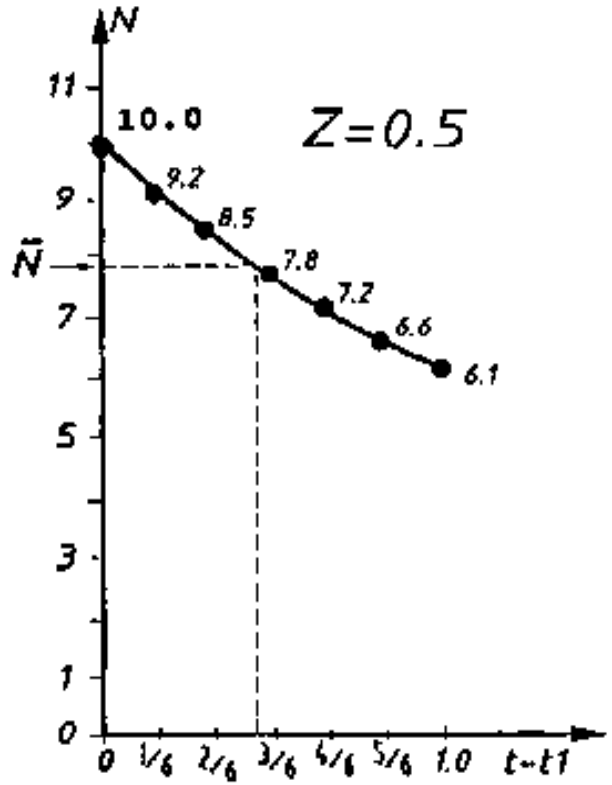
- A "*cohort*" is a batch of fish all of approximately the same age and belonging to the same stock. The concepts "day of recruitment of a cohort" and "recruitment" were introduced. In all the following derivations we assume (with Beverton and Holt, 1957) that a cohort consists of "average fish" only. This means that all fish of a cohort are assumed to have the same age at a given time so that they all attain the "*recruitment age*", Tr, at the same time. We similarly used the average length of a cohort to describe growth. In the context of mortality rates we are interested in the number of survivors from a cohort as a function of time

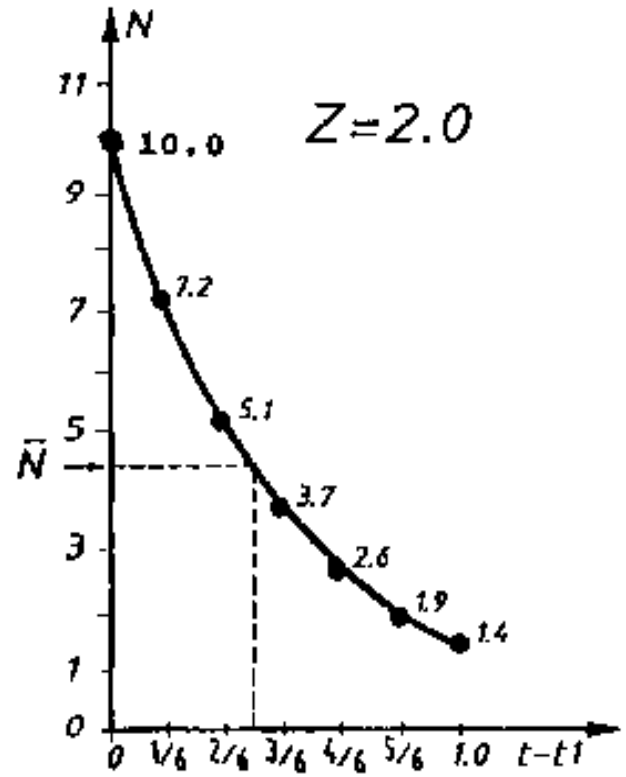
- The symbol "N(t)" is used to designate the "*number of survivors from a cohort attaining age t*". The age is usually measured in units of years. Thus, N(Tr) is the "*number of recruits*" to the fishery. Often the symbol "R" is used to designate the "*recruitment*", R = N(Tr). The actual choice of Tr is not critical, since all calculations are based on relative ages (age differences). In many applications we do not need to define the recruitment age. Tr is the minimum age at which the fish can enter the fishery, i.e. become liable to encounter with fishing gears (Beverton and Holt, 1957). The age at which they actually enter the fishery, Tc, is dependent on the mesh size. Tc is called the "*age at first capture*" and marks the beginning of the "*exploited phase*".


number of survivors
N(Tr)*exp(-Z*(t-Tr))
N(Tr) = R
recruited phase
exploited phase
unexploited
phase
recruit-
ment
first
capture
birth
0
Tr
Tc
age of cohort, t


number of survivors
1976 spring cohort
1977 spring cohort
1975 spring cohort
1976 autumn cohort
1975 autumn cohort
1976
1977
J F M A M J J A S O N D J F M A M J J A S O N D
time


number of survivors
N(Tr)*exp(-Z*(t-Tr))
N(Tr)
80000
60000
N(Tr+0.4)
40000
N(Tr+0.8)
20000
0
total
number
of deaths
N(0.4+Tr)-
N(0.8+Tr)
M/Z*[N(0.4+Tr)-N(0.8+Tr)]
F/Z*[N(0.4+Tr)-N(0.8+Tr)]
Tr 0.4 0.8 2 3 4
0 t1 t2
age of cohort-Tr





Z = 0.5 **Approximation:** $\bar{N} = (10.0+9.2+8.5+7.8+7.2+6.6+6.1)/7 = 7.9$

Exact expression: $\bar{N} = 10.0*[1 - \exp(-0.5)]/0.5 = 7.9$

Z = 2.0 **Approximation:** $\bar{N} = (10.0+7.2+5.1+3.7+2.6+1.9+1.4)/7 = 4.5$

Exact expression: $\bar{N} = 10.0*[1 - \exp(-2.0)]/2.0 = 4.3$