Lov, rybolov, sklizeň / Hunting, fishing, harvesting

Table 16.6 Effects produced in populations of the blowfly *Lucilia cuprina* by the destruction of different constant percentages of emerging adults. (After Nicholson 1954b.)

Exploitation rate of emerging adults	Pupae produced per day (a)	Adults emerged per day (b)	Mean adult population (c)	Mean birth rate (per individual per day) (a/c)	Natural adult deaths per day	Adults destroyed per day (d)	Accessions of adults per day ($e = b - d$)	Mean adult life-span (days) (c/e)
0%	624	573	2520	0.25	573	0	573	4.4
50%	782	712	2335	0.33	356	356	356	6.6
75%	948	878	1588	0.60	220	658	229	7.2
90%	1361	1260	878	1.55	125	1134	126	7.0

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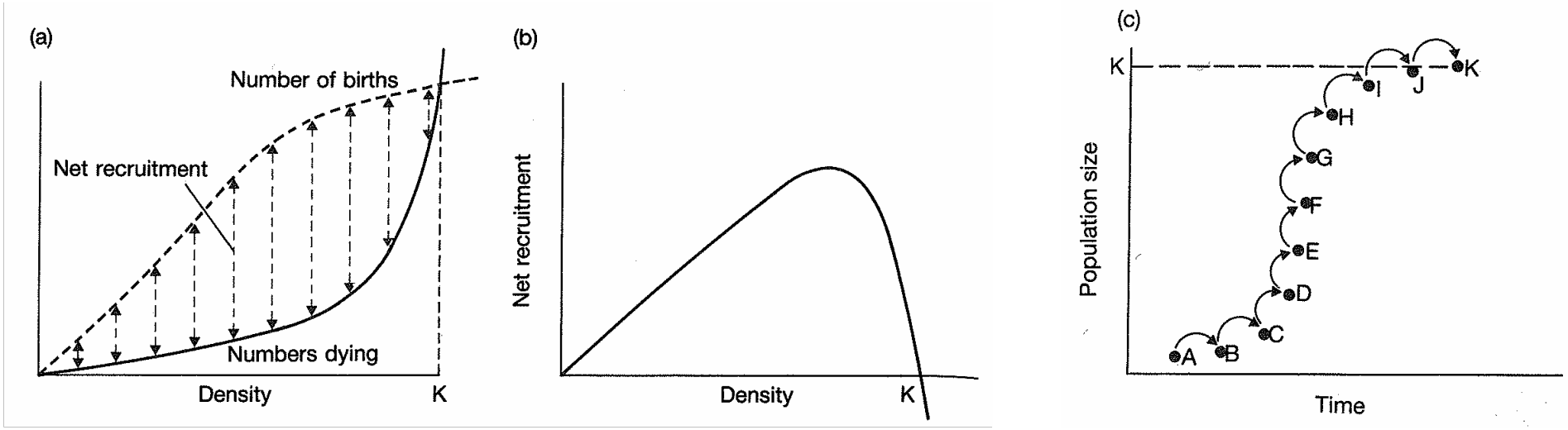
Figure 6.7. Some general aspects of intraspecific competition. (a) Density-dependent effects on the numbers dying and the number of births in a population: net recruitment is 'births minus deaths'. Hence, as shown in (b), the density-dependent effect of intraspecific competition on net recruitment is a humped or 'n'-shaped curve. (c) A population increasing in size under the influence of the relationships in (a) and (b). Each arrow represents the change in size of the population over one interval of time. Change (i.e. net recruitment) is small when density is low (i.e. at small population sizes: A to B, B to C) and is small close to the carrying capacity (I to J, J to K), but is large at intermediate densities (E to F). The result is an 'S'-shaped or sigmoidal pattern of population increase, approaching the carrying capacity.



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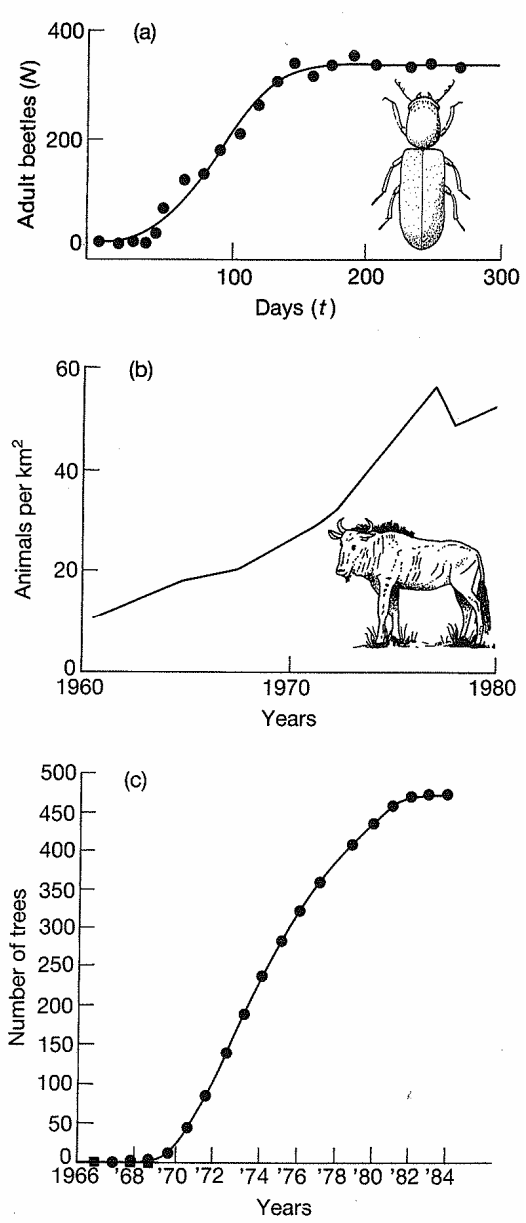

Figure 6.9. Real examples of an 'S'-shaped population increase. (a) The beetle *Rhizopertha dominica* in 10 g of wheat grains replenished each week. (After Crombie, 1945.) (b) The population of wildebeest, *Connochaetes taurinus*, of the Serengeti region of Tanzania and Kenya seems to be levelling off after rising from a low density caused by the disease rinderpest. (After Sinclair & Norton-Griffiths, 1982. From Deshmukh, 1986.) (c) The population of the willow tree, *Salix cinerea*, in an area of land after myxamatosis had effectively prevented rabbit grazing. (After Alliende & Harper, 1989.)

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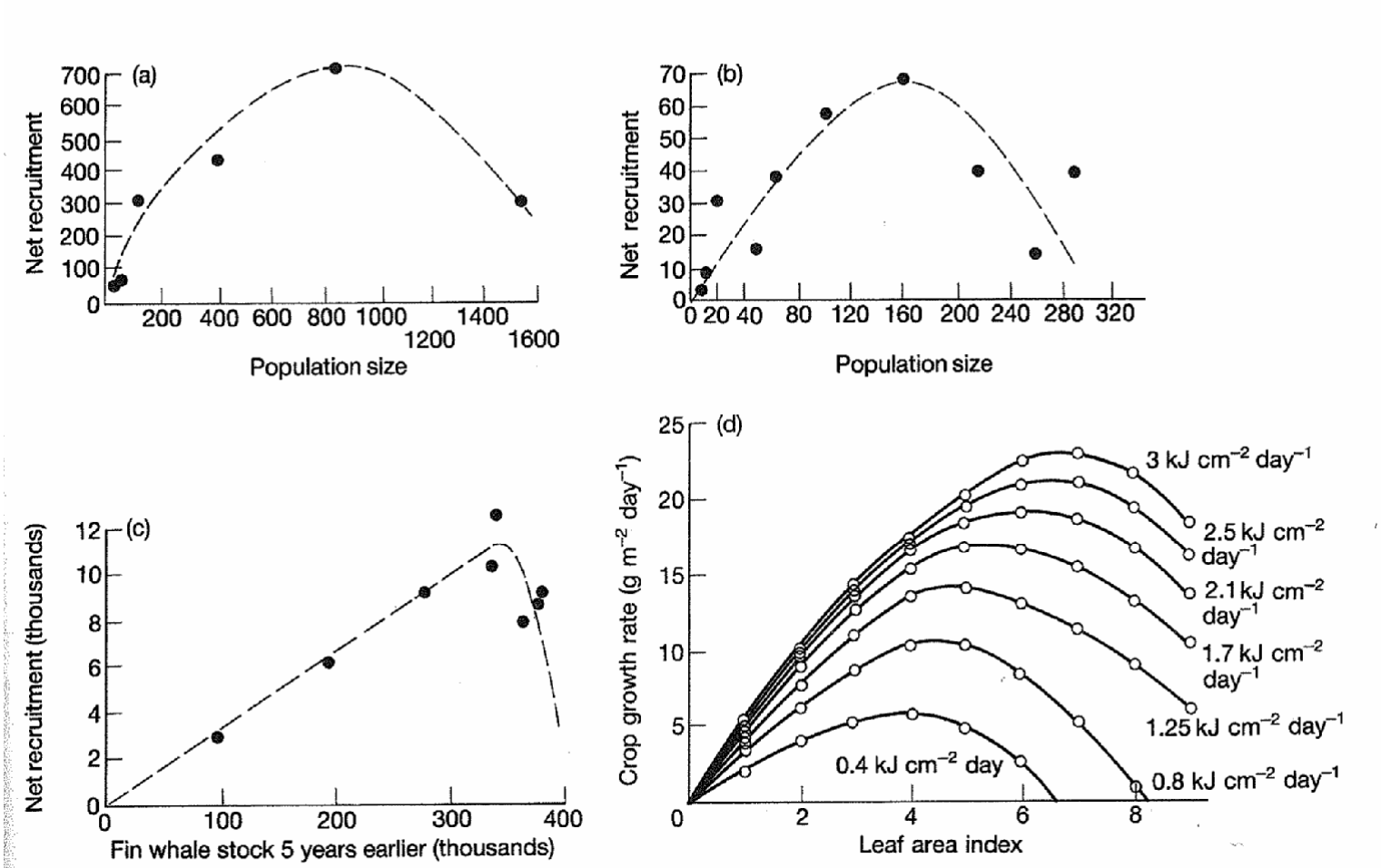

Figure 6.8. Some 'n'-shaped net recruitment curves, drawn by eye through the data points shown. (a) The ring-necked pheasant on Protection Island following its introduction in 1937. (Data from Einarsen, 1945.) (b) An experimental population of the fruit-fly *Drosophila melanogaster*. (Data from Pearl, 1927.) (c) Estimates for the stock of Antarctic fin whales. (After Allen, 1972.) (d) The relationship between crop growth rate of subterranean clover (*Trifolium subterraneum*) and leaf area index (LAI) at various intensities of radiation. Note that the leaf area index at which crop growth rate is maximal depends on the light intensity. (After Black, 1963.)

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To reach a maximal yield while not damaging the population we have to keep population size at N_m.

Abychom dosáhli max. výnosu a přitom nepoškodili populaci, musíme udržet její velikost na hodnotě N_m.

h_m is the highest yield that the population is able to support by its own increment = maximum sustainable yield (MSY)

h_m je nejvyšší sklizeň, kterou je populace schopna vyrovnat vlastním přírůstkem = maximální udržitelná sklizeň

Net recruitment (increment) curve of a hypothetical population

Křivka čistého přírůstku hypotetické populace

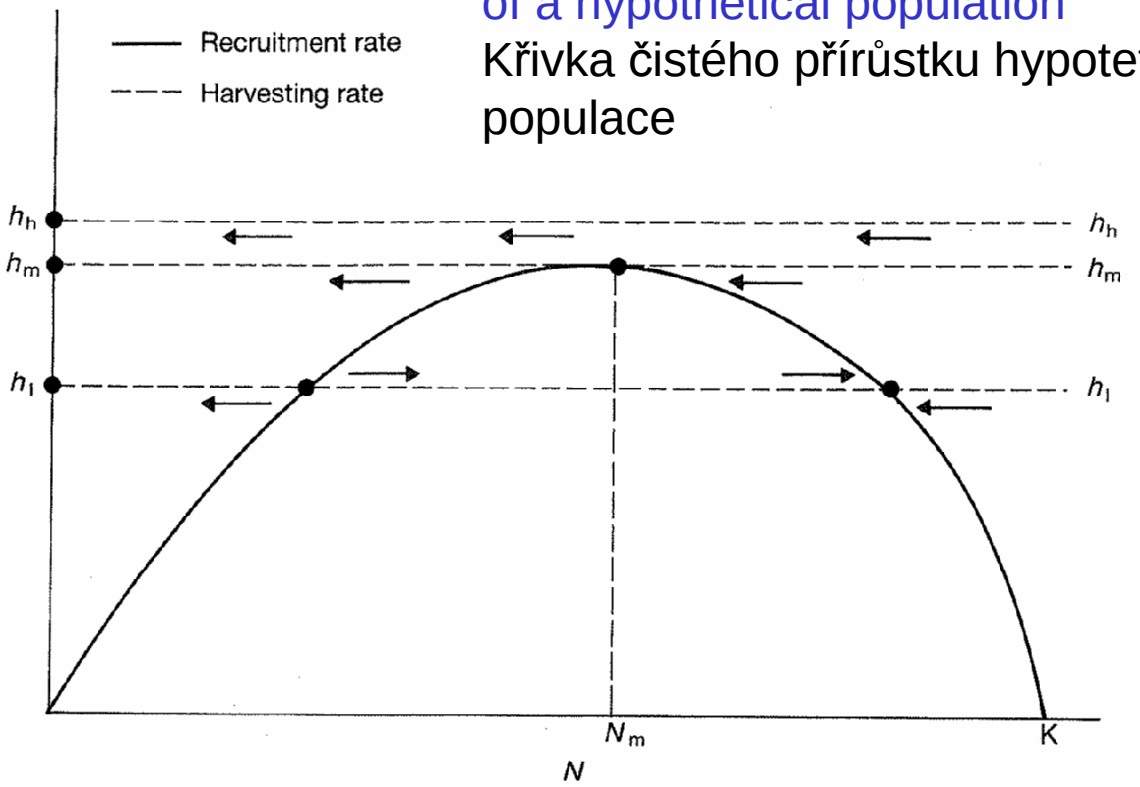

Figure 16.11. Fixed-quota harvesting. The figure shows a single recruitment curve (solid line) and three fixed-quota harvesting curves (broken lines); high quota (h_h), medium quota (h_m) and low quota (h_l). Arrows in the figure refer to changes to be expected in abundance under the influence of the harvesting rate to which the arrows are closest. Dots (•) are equilibria. At h_h the only 'equilibrium' is when the population is driven to extinction. At h_l there is a stable equilibrium at a relatively high density, and also an unstable break-point at a relatively low density. The maximum sustainable yield is obtained at h_m because it just touches the peak of the recruitment curve (at a density N_m): populations greater than N_m are reduced to N_m, but populations smaller than N_m are driven to extinction.

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The highest frequence of harvesting at a medium population density

Nejvyšší frekvence sklizně při střední populační hustotě

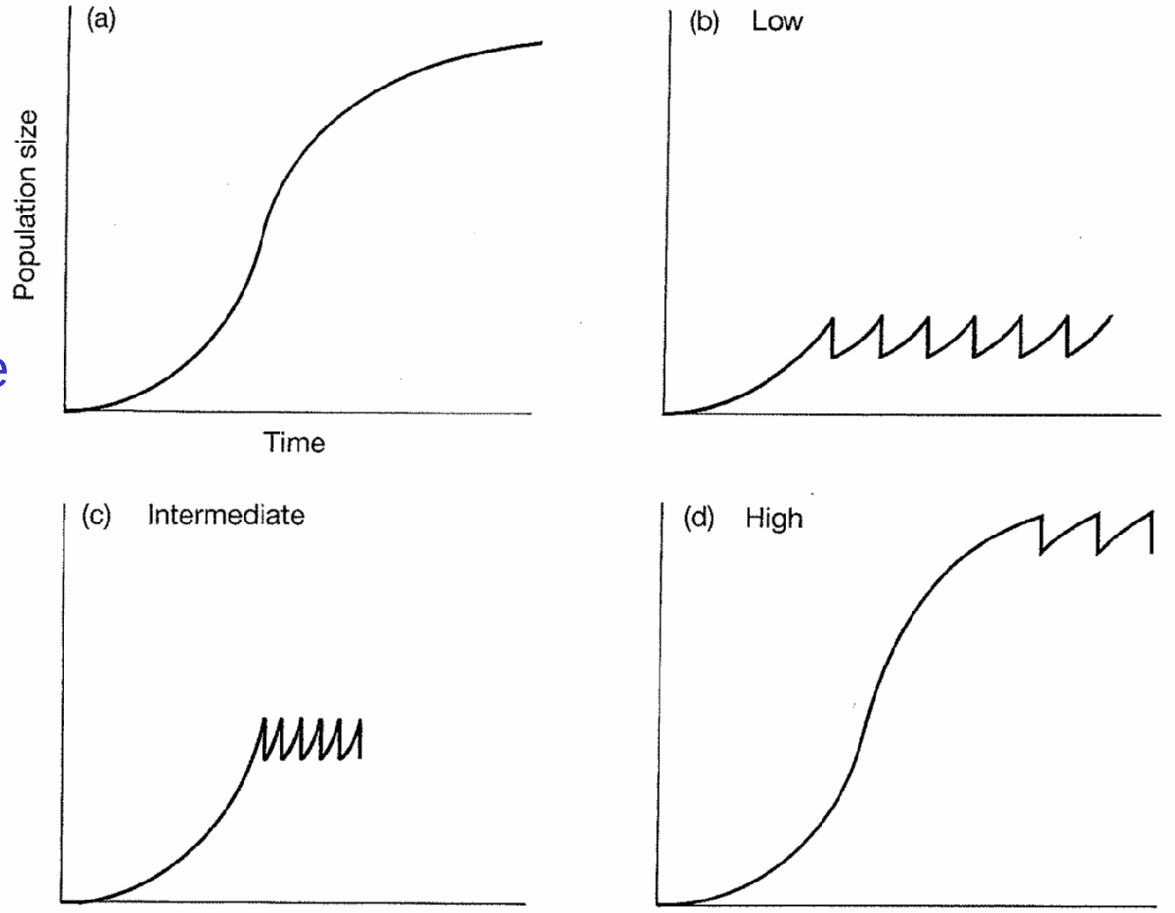

Figure 16.12. For a population exhibiting 'S'-shape growth in size (a), at what density can a harvest of a given size (the vertical lines in (b), (c) and (d)) be taken most frequently? The answer is 'at an intermediate density', shown in (c). At both low (b) and high (d) densities, the rate of growth and thus the frequency of harvest is lower.

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The MSY approach was used by the International Whaling Commission to set fixed annual whaling quota in 1949-1960.

Koncepce maximální udržitelné sklizně byla používána Mezinárodní komisí pro lov velryb pro stanovení pevných ročních kvót odlovu v letech 1949-1960.

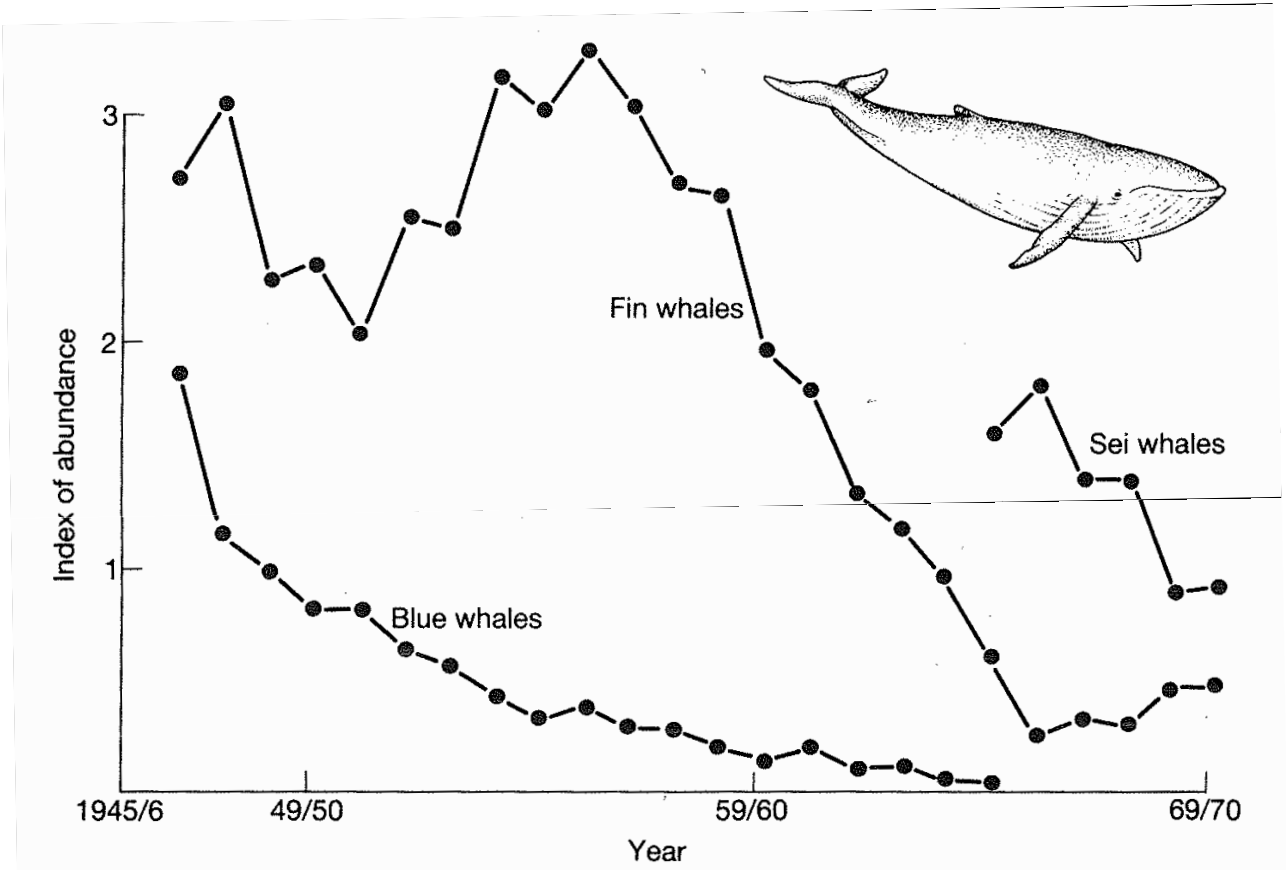

Figure 16.13. The declines in the abundance of Antarctic baleen whales under the influence of human harvesting. (After Gulland, 1971.)

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An alternative to fixed quota is the regulation of harvesting effort.

Alternativou ke stanovení pevných kvót je regulace intenzity sklizně.

$$h = g * E * N$$

h = yield from a harvest / výnos sklizně
g = harvesting efficiency / efektivita sklizně
E = level of harvesting effort / intenzita sklizně
N = population size / velikost populace

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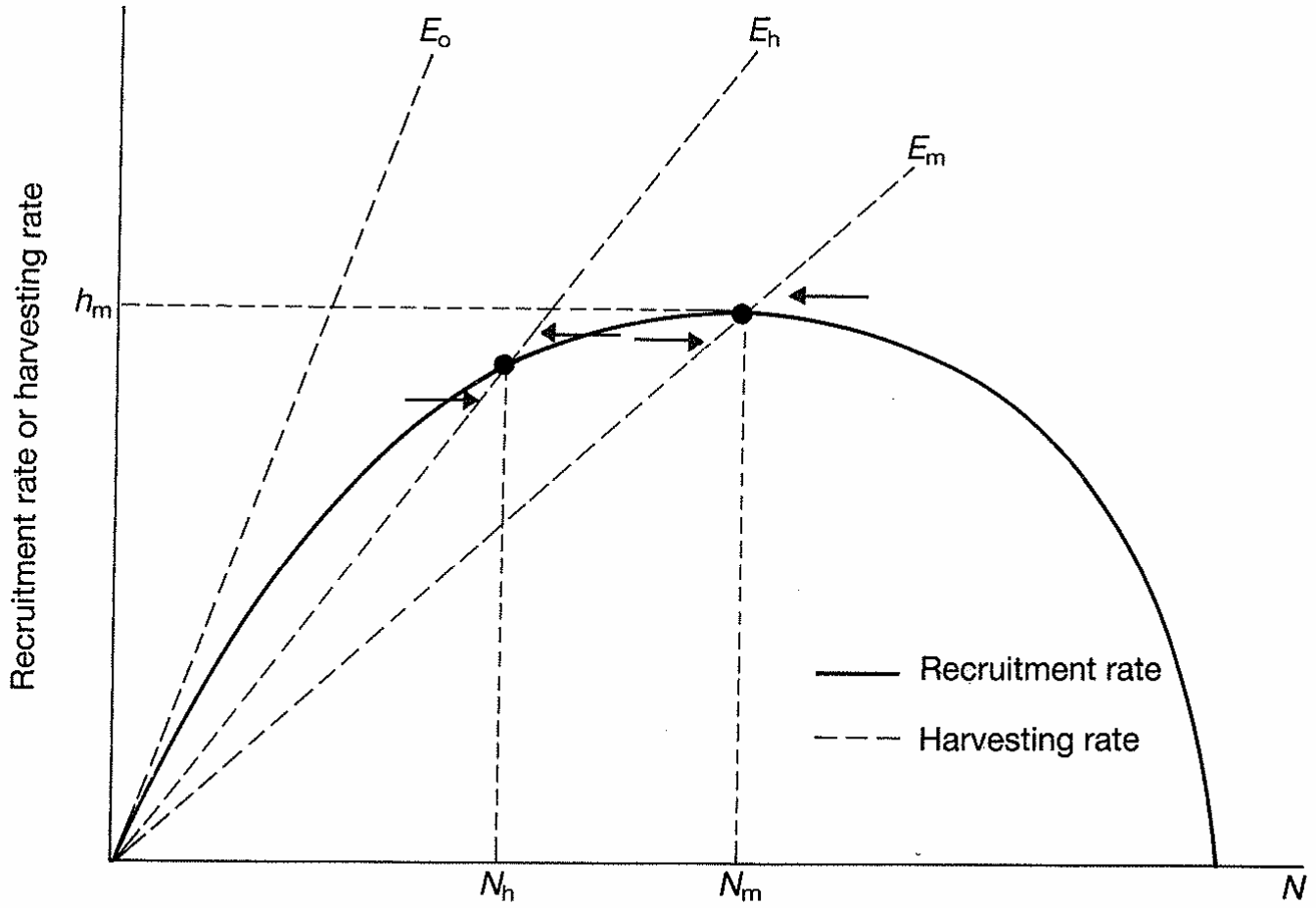

Figure 16.14. Constant-effort harvesting. Curves, arrows and dots as in Figure 16.11. The maximum sustainable yield is obtained with an effort of E_m, leading to a stable equilibrium at a density of N_m with a yield of h_m. At a somewhat higher effort (E_h), the equilibrium density and the yield are both lower than with E_m but the equilibrium is still stable. Only at a much higher effort (E_o) is the population driven to extinction.

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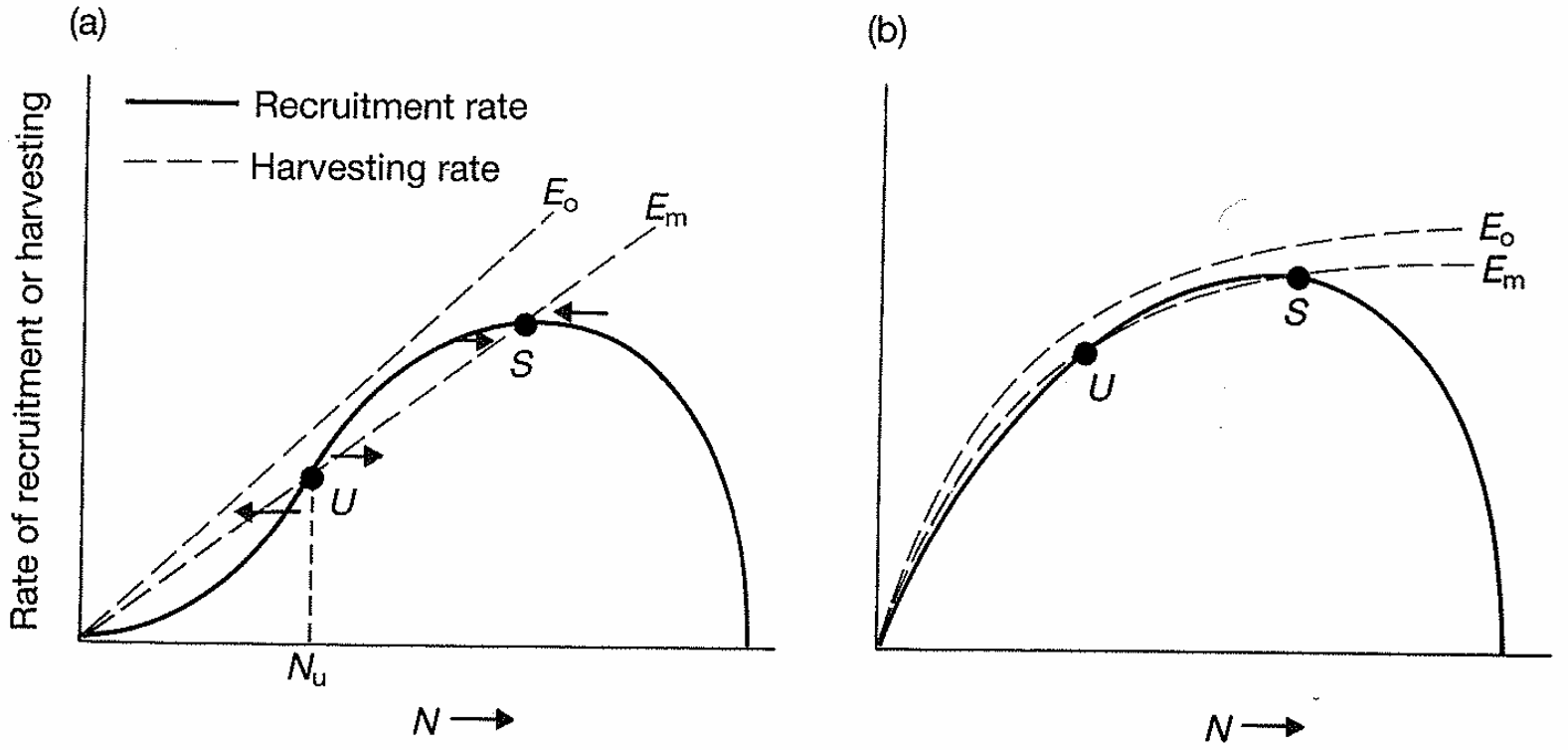

Figure 16.15. Multiple equilibria in harvesting. (a) When recruitment rate is particularly low at low densities, the harvesting effort giving the maximum sustainable yield (E_m) has not only a stable equilibrium (S) but also an unstable break-point (U) at a density below which the population declines to extinction. The population can also be driven to extinction by harvesting efforts (E_o) not much greater than E_m. (b) When harvesting efficiency declines at high densities, comments similar to those in (a) are appropriate.

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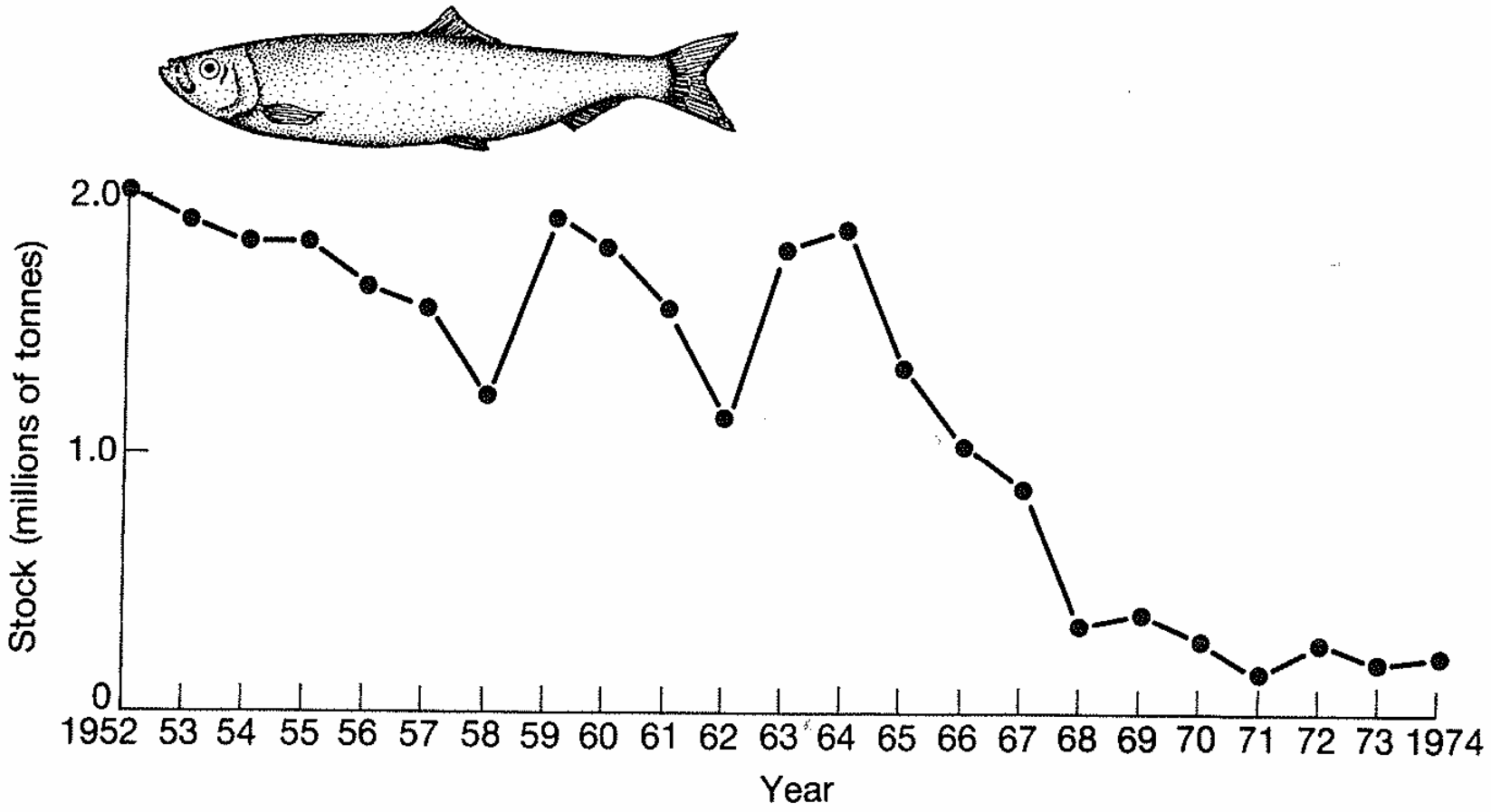

Figure 16.16. The decline in the stock of North Sea herring (measured in millions of tonnes). (After Iles, 1981.)

Pokles populace sledě v Severním moři (měřeno v milionech tun)

Lov, rybolov, sklizeň / Hunting, fishing, harvesting

Surplus Yield Models / Modely sklízeného přebytku

(all introduced above / všechny představené výše)

Alternative approach (more complicated)
/ Alternativní způsob (komplikovanější):

Dynamic Pool Models / Modely dynamických zásob

(the very first one formulated in / první formulován v r. 1957)

Available data on the population (empirical and theoretical) are arranged in such a way to reflect the dynamics of a structured population. Recommendation for the practise includes not only harvesting effort but also its break down to the individual age classes.
Dostupná data o populaci (empirická i teoretická) jsou uspořádána tak, aby odrážela dynamiku strukturované populace.
Doporučení pro praxi obsahuje kromě intenzity sklizně také její rozvržení na jednotlivé věkové skupiny.

Lov, rybolov, sklizeň / Hunting, fishing, harvesting

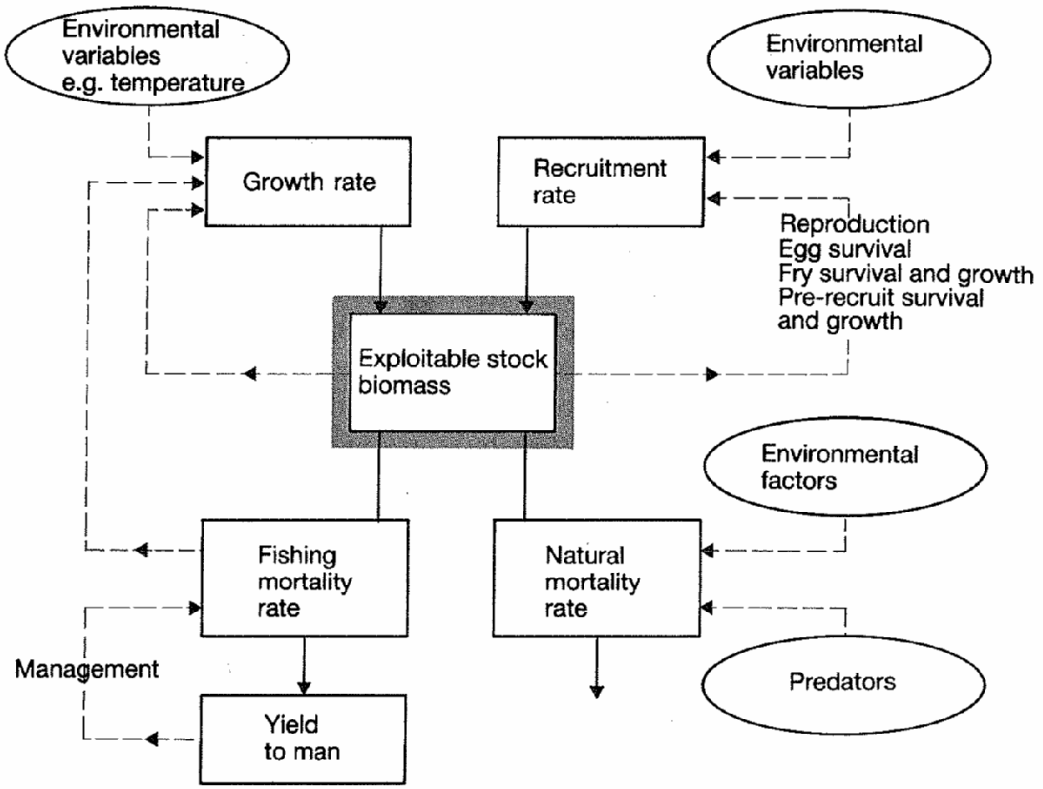

Figure 16.17. The dynamic pool approach to fishery harvesting and management, illustrated as a flow diagram. There are four main 'sub-models': the growth rate of individuals and the recruitment rate into the population (which add to the exploitable biomass), and the natural mortality rate and the fishing mortality rate (which deplete the exploitable biomass). Solid lines and arrows refer to changes in biomass under the influence of these sub-models. Dashed lines and arrows refer to influences either of one sub-model on another, or of the level of biomass on a sub-model, or of environmental factors on a sub-model. Each of the sub-models can itself be broken down into more complex and realistic systems. Yield to man is estimated under various regimes characterized by particular values inserted into the sub-models. These values may be derived theoretically (in which case they are 'assumptions') or from field data. (After Pitcher & Hart, 1982).

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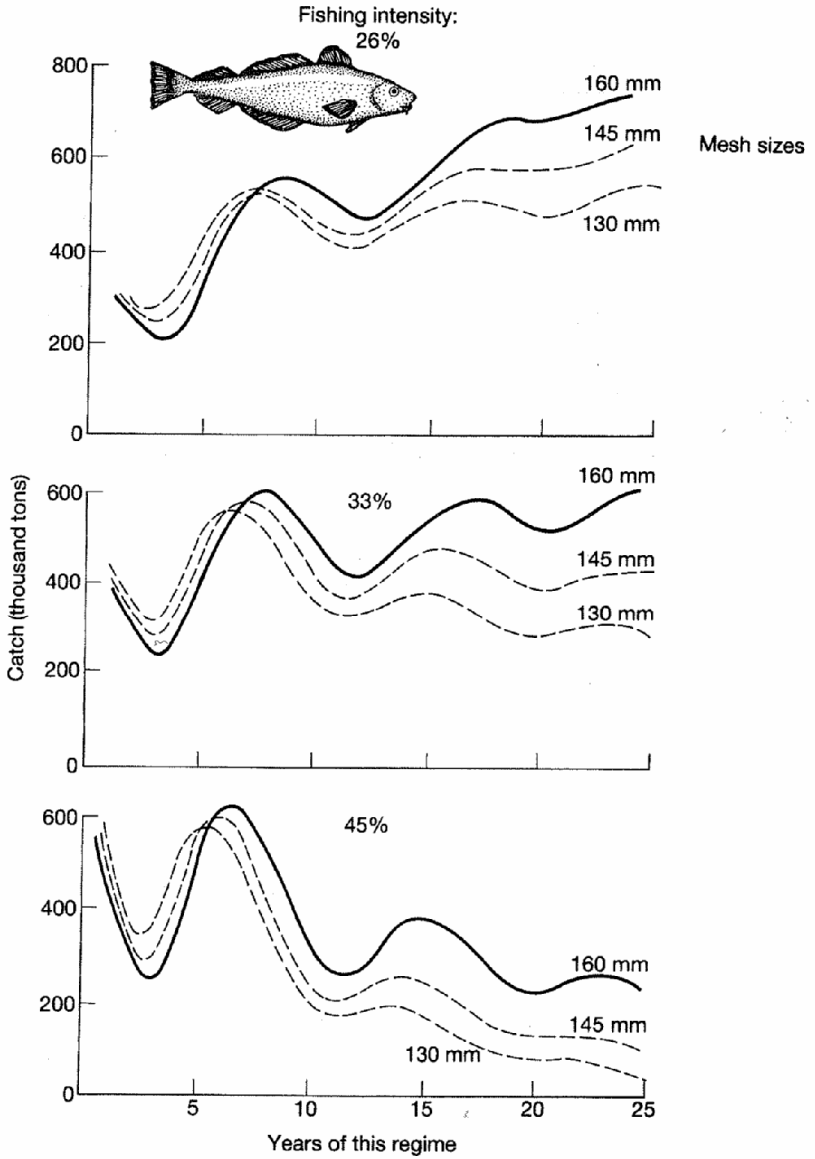

Figure 16.18. Garrod and Jones's (1974) predictions for the Arctic cod stock under three fishing intensities and with three different mesh sizes. (After Pitcher & Hart, 1982.)