

QUAIL HARVEST MANAGEMENT IN TEXAS: A RATIONAL APPROACH

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Abstract: Quail harvest should be managed on intensively exploited properties. "Big government" in the form of state wildlife agencies cannot usurp this role from those managing the property. Although appealing, the hypothesis that a "doomed surplus" of quail exists above a constant "threshold of security" from predators that can be exploited with impunity is not supported by data. Additionally, the additive versus compensatory nature of harvest mortality should be viewed as opposite ends of a continuum rather than a dichotomy. Harvest-induced mortality of northern bobwhite (*Colinus virginianus*) is to some degree additive to other forms of mortality. Moreover, the fuzzy logic implicit to this concept renders it nearly useless as a basis for practical harvest management. Sustained yield (SY) harvest management is independent of these problems and is based upon data collected at the same spatial scale where hunting occurs, an important consideration. Because quail populations have high intrinsic growth rates and harvest rates vary with quail abundance, this is a relatively safe way to manage intensively exploited populations. If one were to implement SY harvest management for a pasture or ranch, one would conservatively estimate the optimum number of quail needed when the breeding season begins, allow for natural mortality during and after the hunting season, subtract these values from the number of quail available prior to the hunting season as determined by density estimates conducted on the property, and allow hunters to harvest the difference. Regardless of how well one manages quail harvest, however, there must be somewhere for quail to live if they are to persist. It is likely that the only way to provide huntable quail populations in perpetuity is to increase or at least retain current quantities of space that quail use throughout the year.

Elsewhere in these proceedings, I pointed out the problems implicit with using the "Procrustean bed" approach of regulating statewide quail hunting to control harvest (Peterson 1999). If quail are to be intensively exploited, harvest management is needed, but is best accomplished at the same spatial scale where hunting occurs. State wildlife agencies, such as the Texas Parks and Wildlife Department (TPWD), primarily control quail hunting, not quail harvest (Peterson 1999). Therefore, it is impossible for "big government" in the form of a state wildlife agency to manage quail harvest at fine spatial scales except on a few state-controlled wildlife management areas (Peterson 1996, 1999). So what is to be done? Numerous biologists have argued that sustained yield (SY) harvest management, conducted on tracts of land where hunting occurs, is the best way to manage harvest for species such as the northern bobwhite (Roseberry 1982; Guthery 1986, 1996; Robertson and Rosenberg 1988; Peterson 1996, 1999; Peterson and Perez 1999). Those managing intensively hunted properties, in particular, should consider this approach.

I first briefly address the shortcomings of the more familiar "doomed" or "harvestable surplus"

perspective toward managing quail exploitation and the associated idea that quail harvest primarily compensates for other forms of mortality. I then outline the theoretical basis of SY harvest management, illustrating why it more appropriately grounds sound quail harvest management on intensively hunted areas. Finally, I briefly summarize how one might implement this approach in the field and point the reader toward more detailed discussions.

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Traditional Harvest Theory

In the early 1930s, Errington (1934) and Errington and Hamerstrom (1935, 1936) observed what they considered to be "constant" spring densities (number per unit area) of northern bobwhite among years on their Iowa and Wisconsin study areas. They hypothesized that these constant quail densities represented the number of birds habitat could adequately keep secure from nonhuman predators during the winter. Errington (1945) later called this the "threshold of security." The number of quail above

this threshold represented a "doomed surplus" (Errington and Hamerstrom 1935) and harvesting these birds simply "compensated" for those that would have died anyway (Allen 1954:129-134). In other words, because these birds were doomed, hunters could shoot them with no detriment to spring breeding densities or population viability. Thence hunter harvest only became "additive" to other forms of mortality if it depressed densities below this threshold of security. There is no doubt that the doomed surplus concept resonated with hunters, outdoor writers, and wildlife managers—it appeared to scientifically justify killing the very animals they all loved (Guthery 1996).

Unfortunately, the doomed surplus approach to harvest management made its way into the lexicon of wildlife managers, outdoor writers, and hunters alike without the benefit of rigorous scientific scrutiny. Interestingly, Errington (1945) himself conceded that, upon further evaluation, he had been wrong about the constant threshold of security. He argued that environmental catastrophes such as blizzards were not covered by his hypothesis and that the threshold was variable anyway. Unfortunately, a hypothesis based on a variable threshold that excludes anything unusual renders it unfalsifiable because an unusual event or a variable threshold could explain any result. Because unfalsifiable hypotheses are meaningless scientifically, the doomed surplus concept as proposed, should have been laid to rest. It already had gained too much popularity, however, to be easily quashed by facts (Guthery 1996). At any rate, the notion that spring quail densities are constant regardless of production or harvest has been thoroughly discredited (e.g., Errington 1945, Roseberry 1979, Roseberry and Klimstra 1984, Dixon et al. 1996). Interestingly, after Lack (1954) proposed that a density-dependent scarcity of food in late winter regulated spring bird densities because starvation caused a "winter bottleneck," many biologists simply assumed that the number of quail in excess of this bottleneck was now the doomed surplus.

Anderson and Burnham (1976) helped move biologists away from viewing the additive versus compensatory nature of harvest mortality as a dichotomy. They argued that for mallards (*Anas platyrhynchos*) at least, harvest mortality was somewhere between these 2 extremes and that complete additivity and compensation should be viewed as opposite ends of a continuum. Anderson (1975) and Anderson and Burnham (1976) argued that hunter exploitation of species with high reproductive potential (often called r-selected), such as quail, was

largely compensatory with other forms of mortality. Similarly, harvest mortality was assumed to be largely additive for long-lived species with low reproductive outputs (often called K-selected) such as baleen whales. Evaluation of data from quail populations subjected to harvest failed to demonstrate complete compensation (Roseberry 1979, Roseberry and Klimstra 1984:139-150, Curtis et al. 1989, Pollock et al. 1989, Robinette and Doerr 1993, Dixon et al. 1996). In fact, Roseberry and Klimstra (1984: 139-150) found that bobwhite harvest on their southern Illinois study area was near the additive end of the spectrum. Survival also was significantly lower in hunted as compared to nonhunted study areas in Florida (Pollock et al. 1989), North Carolina (Robinette and Doerr 1993), and South Carolina (Dixon et al. 1996). Additionally, Roseberry and Klimstra (1984:139-150), Robinette and Doerr (1993), and Dixon et al. (1996) demonstrated that hunter harvest becomes increasingly additive to other forms of mortality as the hunting season stretches into late winter. Clearly, the degree to which exploitation of quail populations is additive to other forms of mortality is unclear and no doubt varies among habitat regions.

Guthery (1996) argued that the fuzzy logic implicit in the additive versus compensatory construct is detrimental to sound management of quail harvest and has confused the public and biologists alike. Similarly, one could argue that ideas such as the threshold of security, doomed surplus, winter bottleneck, and additive versus compensatory mortality fall dangerously close to what Macnab (1985) referred to as slippery shibboleths—code words used by the initiated (inside crowd) having no precise definition. For example, what, exactly, does "partially additive," "primarily compensatory," or "increasingly additive" mean? These terms are comfortably vague and fuzzy and mean anything you want them to mean. For these reasons, numerous biologists (e.g., Brennan 1991, Burger et al. 1994, Peterson and Perez 1999) have called for experiments designed to determine the effect of harvest timing and intensity on the number of quail available to breed the next season that are conducted at the same spatial scale where quail are hunted.

While we are waiting for such data to be developed, can we scientifically manage the quail harvest on a given ranch or other property? Yes we can. Sustained yield harvest theory does not require us to understand the degree to which hunter harvest is additive to other forms of mortality. In fact we can

ignore the fuzzy notions of additivity and compensation entirely if we prefer (Guthery 1996). Sustained yield harvest management relies on information collected from the property where hunting occurs, so it lends itself to managing quail harvest at this spatial scale. This is particularly important when exploitation is intense.

Sustained Yield Harvest

If a your property supports high densities of quail on 100,000 acres and you plan to hunt only a couple of days, if at all, during a given year, the remainder of this article can be skipped. You already manage quail harvest exceeding conservatively. If, however, you intend to hunt pastures more intensively, you should consider the following.

Theory

Animal populations tend to exhibit sigmoid (S-shaped) growth curves (Fig. 1A; Roseberry 1982, Robertson and Rosenberg 1988). This means that, in suitable habitat, the number of animals in the population initially increases slowing, gains momentum, then slows again as numbers reach the maximum that can be supported by the habitat for the long term. This equilibrium where births equal deaths (K) is not a constant over time, so the top of this curve actually would fluctuate. Net recruitment of quail into a population (Fig. 1B) is directly related to the shape of the population growth curve (Fig. 1A)—with recruitment being highest at the same population density where the growth curve is steepest. If a manager's goal is to harvest the greatest sustainable number of quail from his/her property, s/he should maintain numbers of quail during the reproductive season at this level—called maximum sustained yield (MSY; Fig. 1).

If a population is exploited at MSY by harvesting at a fixed rate or quota, as was commonly attempted for commercial fisheries in the past, it is important to know almost exactly how many animals to take, because even slight "over harvest" could lead to extinction (Fig. 2A). For this reason, most biologists who must use fixed rate harvest schemes suggest harvest levels somewhat less than MSY. This is often called optimal sustained yield. At any rate, any level of harvest less than MSY is still a SY harvest (Fig. 2A).

For most upland gamebird species, harvest rates actually vary with game abundance. In Texas, for example, roughly twice as many hunters hunted quail during "boom" as opposed to "bust" years (Peterson and Perez 1999). Similarly, quail abundance, as determined by TPWD quail surveys, accounted for 77 and 87% of the variability in the total number of northern bobwhite and scaled quail (*Callipepla squamata*), respectively, harvested annually in Texas. For this reason, quail recruitment and harvest rates maximize at the same population size—MSY (Fig. 2B). Again, various SY harvest levels can be implemented (Fig. 2B). Because recruitment curves for northern bobwhite are fairly symmetrical (Fig. 1B), the harvest rate must be quite high before it leads to extinction (Fig. 2B). For this reason, knowing exactly where MSY should be is not nearly as critical for variable versus fixed harvest rates (Fig. 2).

It is important to realize that the shape of the recruitment curve underlies SY harvest management. If recruitment curves representing quail and baleen whales are compared (Fig. 3), we can easily see why whales are innately more vulnerable to extinction caused even by regulated exploitation (Fig. 3). For whales, there is almost no difference between MSY and a harvest rate leading to extinction. Animals such as Rocky Mountain elk (*Cervus elaphus*), white-tailed deer (*Odocoileus virginianus*), geese, and wild turkeys (*Meleagris gallopavo*) fall somewhere on the continuum between these extremes. I bring up this point because one cannot assume that recruitment curves for all quail populations look like the one I used (Figs. 1-3). For example, quail populations on small, fragmented habitats might have recruitment curves frighteningly similar to those of whales and are exceedingly vulnerable to extinction whether harvest occurs or not. For this reason, it is important that SY harvest management be specifically tailored to the area where hunting will occur.

Practice

It is beyond the scope of this article to provide a "cookbook" for SY management of quail harvest. Instead, I briefly lay out the general tasks that must be completed. Many land managers will want to hire a qualified wildlife biologist with experience in SY management of quail harvest to help with the initial design and implementation of such a program.

Sustained yield harvest management must be based on quail data collected from the area to be

hunted. First, density estimates for hunting units (pastures or ranches) must be collected prior to the hunting season (late summer or early fall). Typically this involves some sort of population survey that is then extrapolated to estimate the number of quail for the hunting unit (Guthery 1986, Caughley and Sinclair 1994:190-216, Lancia et al. 1994). These estimates can be compared among years as a measure of productivity. Because considerable work and a rational approach is needed, some managers might want to take advantage of available rules of thumb (Guthery 1986), particularly if hunting pressure is not too intense. Next, the number of quail you want available to breed is estimated. Rules of thumb based on quail density also are available to help with this estimate (Guthery 1986, Guthery and Kuvlesky 1998). At any rate, be conservative. Err on the side of leaving too many quail. Lastly, subtract this number, allowing for other forms of mortality expected during and after the hunting season, from the total number of quail on the hunting unit to derive the maximum number of quail to be harvested from the area.

One also must keep scrupulous harvest records including data such as age and sex of quail bagged (Cain and Beasom 1983, Koerth et al. 1991), location of kill, number of hunters, time spent hunting, and numbers of crippled birds (Guthery 1986). Crippled birds are counted as harvested. Once the SY limit is reached, stop harvesting. One can spread hunting opportunity around to any degree wished by implementing techniques such as limiting gun hours, setting conservative daily bag limits, limiting the number of times a covey can be flushed, and resting hunting units. A note of warning for intensely exploited areas: if your operation hunts baited roads from vehicles, the SY limit may be reached more rapidly than anticipated.

It is important to repeat these steps annually, making sure to reevaluate your choice of numbers leading to the SY harvest limit in light of data collected. For example, you could use your pre-hunt survey as an index to population trends among years. This could be compared to trend data available from TPWD for your ecological area (Peterson 1999, www.tpwd.state.tx.us). If quail productivity on your property dropped while that of your physiographic region was booming, you might consider modifying the values you chose for preferred breeding density or nonharvest-related mortality. Fortunately, the nature of quail population dynamics (Figs. 2-3) is such that there is time to catch a problem and correct it. One also should compare harvest data among hunting units

and determine how well harvest mirrors production (Peterson and Perez 1999). Finally, these data not only will help determine how to modify harvest strategies for specific hunting units, but also should help determine whether to invest money in habitat modifications or other wildlife management practices. As with any well-run business, data are required for sound management.

Summary And Discussion

State wildlife agencies such as TPWD can regulate quail hunting, but are not well suited to micromanaging quail harvest (Peterson 1996, 1999). After all, hunting and harvest are not the same thing. For example, Peterson (1999) found that if the daily bag limit in Texas was reduced from 15 to 8, only about 11 and 7% of northern bobwhite and scaled quail hunters would be impacted, while harvest might be reduced by 27 and 15%, respectively. Worse yet, changes in daily bag limits are regressive because they restrict harvest most when restrictions are least needed. Similarly, few Texas quail hunters spend >12 days in the field, so small reductions in the season length would not be expected to alter harvest. For these reasons, if you want to intensively exploit quail resources on a given piece of property, you are obliged to manage quail harvest on that same property. This task appears daunting in view of the volatility in quail abundance observed among years (Peterson 1999). This job cannot be foisted on big government, however. For example, TPWD simply does not have the resources necessary to manage quail harvest at this fine scale except on a few state-controlled wildlife management areas.

Unfortunately, traditional harvest theory is not particularly useful for guiding informed management of quail harvest. The idea of a "doomed surplus" (Errington and Hamerstrom 1935) existing above a constant "threshold of security" from predators (Errington 1945) that could be exploited with impunity certainly appealed to those interested in quail hunting. Upon examination, however, there was no constant threshold (Errington 1945, Roseberry 1979, Roseberry and Klimstra 1984). A variable threshold that excluded environmental catastrophes, rendered Errington's (1945) threshold of security hypothesis unfalsifiable. Rather than being eliminated from the minds of biologists, hunters, and outdoor writers, the popular idea of a doomed surplus simply was transferred along as other hypotheses regarding harvest management came in vogue.

A corollary to the threshold of security hypothesis was that exploitation became additive to other forms of mortality only when it reduced quail density below the threshold of security. Conversely, lower harvest rates simply substituted for other forms of mortality. It later became obvious that the additive versus compensatory nature of harvest mortality should be viewed as opposite ends of a continuum rather than as a dichotomy (Anderson and Burnham 1976). Well-designed studies of northern bobwhite populations demonstrated that hunter harvest is to some degree additive to other forms of mortality and typically becomes more so late in the hunting season (Roseberry 1979, Roseberry and Klimstra 1984:139-150, Curtis et al. 1989, Pollock et al. 1989). Moreover, although the additive/compensatory construct has heuristic value, the fuzzy logic implicit to the concept makes it difficult to base practical harvest-management programs upon (Guthery 1996).

Sustained yield harvest management is independent of the theoretical problems described above. Additionally, it is based on information collected at the same spatial scale where hunting occurs, so it lends itself to formulating practical harvest management plans. It is grounded on the fact that more quail can be harvested in perpetuity at densities where population growth is most rapid (Figs. 1-2; Roseberry 1982, Robertson and Rosenberg 1988). Because quail populations have high intrinsic growth rates (r), and harvest rates vary with quail abundance (Peterson and Perez 1999), this is a relatively safe way to manage intensively hunted quail populations. Simplistically, if one were to implement SY harvest management for a large pasture or ranch, one would conservatively estimate the optimum number of quail needed when the breeding season begins, account for natural mortality during and after the hunting season, subtract these values from the number of quail available prior to the hunting season as determined by density estimates conducted on the property (Guthery 1986, Caughley and Sinclair 1994:190-216, Lancia et al. 1994), and allow hunters to harvest the remainder (Guthery 1986). This is actually an iterative process, where production, harvest records, and other data are used to tune harvest management over time (Walters 1986).

I end with a caveat. Regardless of how well one manages quail harvest, there must be somewhere for quail to live if you are to enjoy them for long. For example, many people wonder why northern bobwhite numbers have declined for years in the Cross Timbers and Prairies of Texas (Peterson 1999). It is simple.

Seas of coastal Bermuda pasture and suburban sprawl do not provide many homes for quail. Quail abundance would have declined in this physiographic region with or without harvest. Harvest management certainly is necessary for intensely hunted areas, but is not a silver bullet that will bring high bobwhite densities to downtown Fort Worth. Guthery (1997) argued that the best way to ensure that huntable northern bobwhite populations persist is to increase the quantity of space they can use throughout the year. In other words, managers should focus on increasing, or at least retaining, the amount of habitat available, rather than increasing the "quality" of habitat already in use. Guthery (1999) further suggested that there is considerable "slack" in the configuration of habitat patches used by bobwhites. Therefore, bobwhite production can be compatible with a broad spectrum of land uses as long as barriers associated with patch configuration are limited. Remember, no matter what quail management strategies are implemented, if there are no homes for quail, they will not persist in huntable numbers for long.

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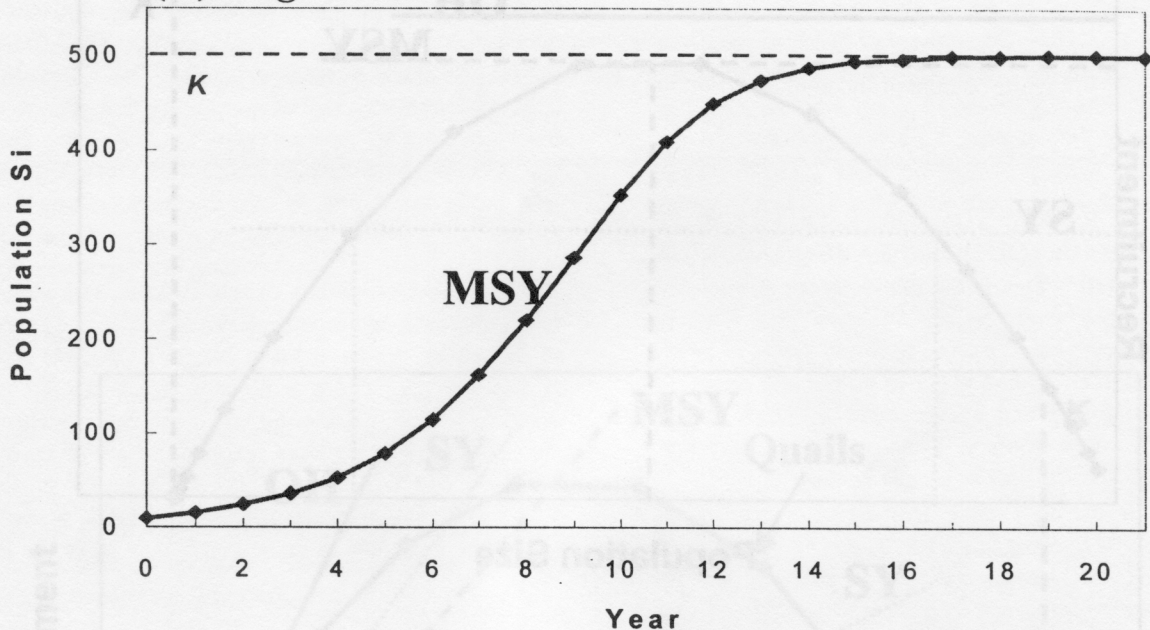
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(A) Logistic Growth



(B) Recruitment

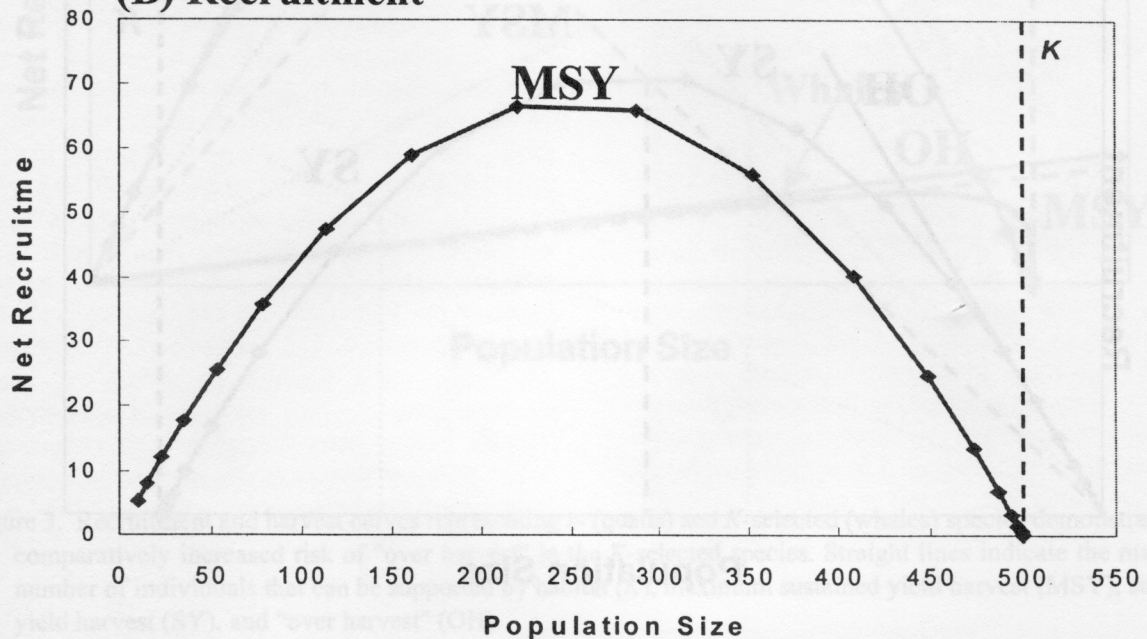
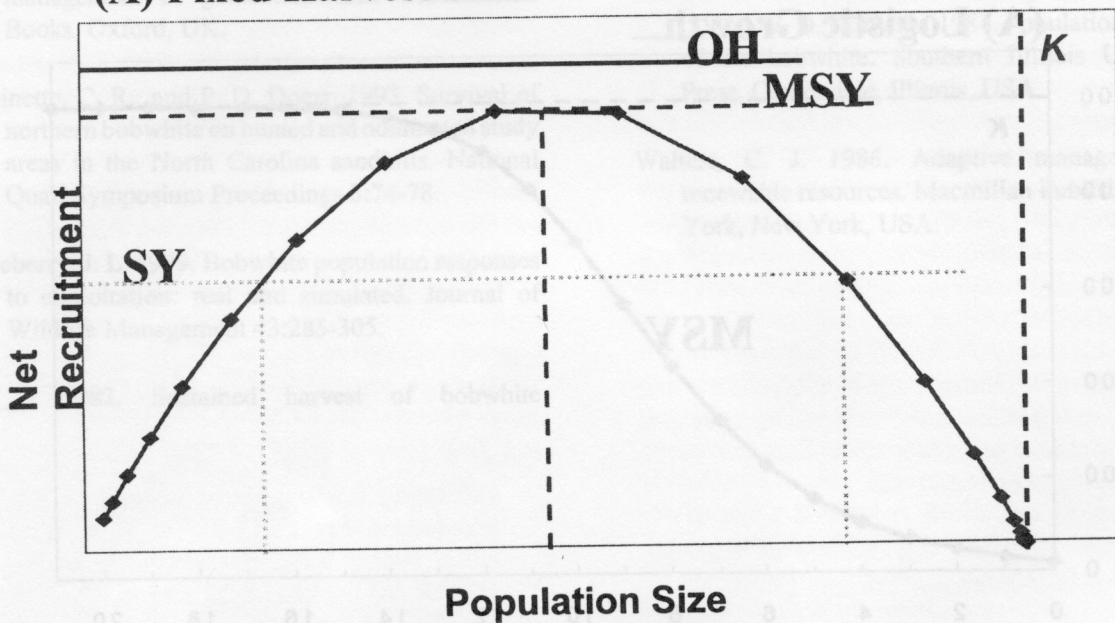


Figure 1. The (A) logistic growth and (B) recruitment curves associated with a simulated northern bobwhite population. Straight lines indicate the maximum number of quail that can be supported by habitat (K) and maximum sustained yield harvest (MSY).

(A) Fixed Harvest Rate



(B) Variable Harvest Rate

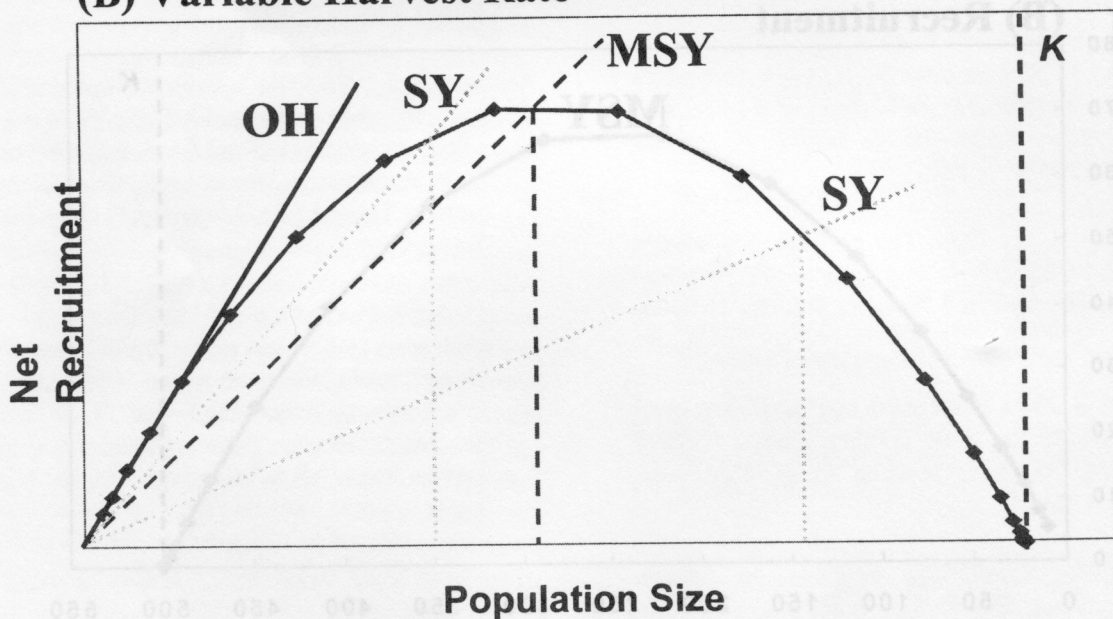


Figure 2. Recruitment and harvest under a (A) fixed and (B) variable harvest rate. Straight lines indicate the maximum number of quail that can be supported by habitat (K), maximum sustained yield harvest (MSY), 2 levels of sustained yield harvest (SY), and "over harvest" (OH). Harvest lines are rise diagonally because the harvest rate increases as recruitment increases.

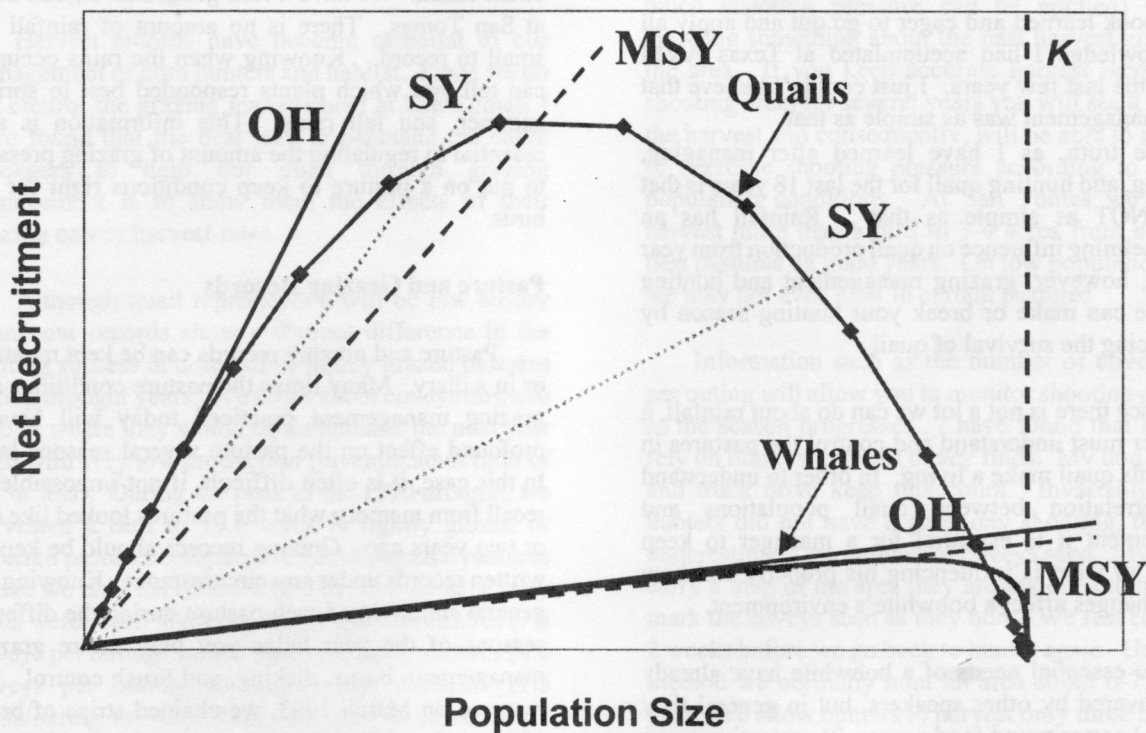


Figure 3. Recruitment and harvest curves representing *r*- (quails) and *K*-selected (whales) species demonstrating the comparatively increased risk of "over harvest" in the *K*-selected species. Straight lines indicate the maximum number of individuals that can be supported by habitat (*K*), maximum sustained yield harvest (*MSY*), sustained yield harvest (*SY*), and "over harvest" (*OH*).