3.0 AFFECTED ENVIRONMENT

This chapter describes the affected environment, which is the baseline environmental condition. The baseline represents the status of environmental attributes at a time before the proposed action is implemented, and in Chapter 4 serves as a point of comparison to evaluate possible significant impacts. (The baseline differs from the *Status Quo*, which predicts a future environmental state in the absence of any action alternative.) Because the proposed action is procedural, it will not directly affect the biological or sociological environment. It will affect the management regime in terms of capacity, flexibility and public perceptions. Therefore, the affected environment description in this chapter focuses on these management-related issues. For information on the biological and socioeconomic environment the reader may consult the EIS analyzing the 2003 harvest specifications and management measures for the Pacific Coast groundfish fishery (PFMC 2003). It provides a detailed description of the habitat, species, fisheries and fishing communities, and management issues related to groundfish. In addition, an EIS is being prepared in connection with Amendment 16-2, which evaluates rebuilding plan alternatives for darkblotched rockfish, Pacific ocean perch, canary rockfish and lingcod. It is being prepared concurrently with this EA. Because the rebuilding measures adopted in those rebuilding plans are expected to directly affect the human environment, that EIS describes those resources. This chapter is divided into two main sections describing the management regime, and issues related to the choice of rebuilding strategy. Chapter 4, evaluating the environmental impacts of the alternatives, has a corresponding structure.

3.1 Current Management Regime

The process and standards for adopting rebuilding plans, comprising the proposed action, directly affects the management regime. In Chapter 4 effects to the management regime are evaluated in terms of three issues: administrative capacity, flexibility or adaptive management, and public participation. Baseline information related to these three issues is provided here.

3.1.1 Administrative Capacity

Administrative capacity is a measure of the time available to and productivity of the administrators of the management regime. This can be attributed to each element of the management system: Council members, advisory bodies, Council staff, NMFS staff, and state agency staffs. Capacity is more or less a constant, because the Council meets for defined periods of time and staffs have some total amount of work time. (This assumes no significant expansion in the number of staff.) Because capacity is fixed and administrative capacity fully utilized, the time cost of any management measure actually represents a tradeoff: time spent on one task means less time spent on another. Procedural measures can be assessed in terms of complexity; the more complex the task of implementing and “maintaining” the procedure the more organizational capacity will be required. This means that organizational attention and capacity is shifted away from other tasks that may be equally pressing or important. The allocation of resources among different tasks can have difficult-to-predict indirect effects on the environment if the implementation of management measures are delayed or organizations do not have the opportunity to address broad issues strategically.

NMFS and the states have researchers and professional staff that participate in the formulation of management measures (for example, by conducting the stock assessments used to determine optimum yields). Council advisory bodies, such as the GMT and GAP also play a central role in identifying management targets and measures, and conducting the necessary supporting analyses. All of these personnel may contribute to the preparation of amendment documents. However, the task of preparing the analytical and informational documents required when amending an FMP and promulgating regulations falls mainly on the professional staff employed by the Council and NMFS. (Within NMFS, staff at the NWR are responsible for actions related to the groundfish FMP.) Generally, Council and NWR staffs divide responsibility for preparing of groundfish-related FMP amendment documents, with one or the other office taking the lead. In addition, if a particular action requires the promulgation of regulations, NMFS NWR staff are responsible for preparing these regulations.

The Council has two staff officers working on groundfish, who devote essentially 100% of their time to groundfish-related tasks. (Time spent on FMP/regulatory amendments is limited by a range of other responsibilities, such as staffing workshops and advisory body meetings and preparing briefing materials for

Council meetings.) Two economists carry out economic analysis in support of a range of Council actions, but devote between 35% and 50% of their time to groundfish-related actions. One staff officer ensures that Council processes and documents comply with NEPA-related regulations and also spends about 35% to 50% of his time working on groundfish-related matters. Three other professional staff devote a small amount of time to groundfish-related work, with the primary responsibilities elsewhere.

NMFS NWR has five staff that spend part or all of their time on groundfish-related analysis and regulatory implementation, although not all of their groundfish workload is associated with Council activities. (This excludes fishery scientists working for NMFS who conduct stock assessments and related scientific tasks.) The NWR also has a NEPA coordinator responsible for the development and review of analytical documents and agency NEPA procedures. While Council staff prepare amendment documents (including required environmental and regulatory analyses) and support the Council decision-making process, NMFS staff are responsible for tasks related to the implementation of regulations. They also prepare amendment documents, but are less involved in Council administrative support, for example by staffing Council meetings.

It is very difficult to assess the capacity of these resources, for example in terms of the number of amendments or actions that can be completed in a given time period. In part this is due to the wide variation in the complexity of different management actions and the fact that no one person works full time on a single action; usually several actions are ongoing and other tasks are also part of staff duties. Taking the staff identified above as a whole, at least 20% and possibly as much a third of their time of is directly related to the preparation of the analyses and documentation necessary to implement an amendment or action. (This estimate includes other activities such as rulemaking, including the implementation of seasonal management.) It is also important to note that fishery scientists at NMFS and state agencies carry out much of the analyses supporting management decision-making.

One can also evaluate capacity in terms of the time needed to implement a management action. This also varies tremendously, depending on the nature and complexity of the action. Implementation of periodic or seasonal management has to be completed in a relatively short time period because of the need for fishing regulations to be in place at the beginning of the season. For this reason, a substantial portion of staff resources may be taken up for a relatively short period of time. For example, during the second half of 2002 close to half the staff capacity described above was committed to implementation of groundfish specifications and management measures for 2003. FMP amendments are typically on a more extended schedule, driven in part by Council deliberation and decision-making and also the review requirements within NMFS. Generally speaking, it takes at least six to nine months to implement an FMP amendment, although it is not uncommon for a year or more to elapse because of Council deliberations and the availability of staff to do the work. (This amendment offers a good example. Work began in late 2001 and final approval is expected some time in the latter half of 2003. This extended period is due to the need for the Council to deliberate and the fact that for much of the second half of 2002, most staff time was devoted to implementation of 2003 specifications and management measures.)

A fair assessment would be that Council and NMFS staff have the capacity to complete one or two groundfish FMP amendments per year, if they are of moderate complexity. It should also be noted that a more regulatory amendments—which effect changes in federal regulations as opposed to the FMP—are usually completed in a given time period. NMFS staff bear a larger share of the work needed for these actions than Council staff does. Considering Council and NMFS staffs together, groundfish-related action requiring notice and comment rulemaking requires an equivalent amount of staff capacity.

3.1.2 Adaptive Management

The concept of adaptive management was first developed in the 1970s (Holling 1973) and has been applied widely. Adaptive management assumes uncertainty, promotes "learning" strategies, and envisions a cyclical management process in which management measures are refined in response to new information and understanding of the managed system. A review of adaptive management of Columbia River salmon (Lee and Lawrence 1986) describes it as "a policy framework that recognizes biological uncertainty, while accepting the congressional mandate to proceed on the basis of the 'best available scientific knowledge.' An adaptive policy treats the program as a set of experiments designed to test and extend the scientific basis of fish and wildlife management." Gunderson (1999) argues that flexibility in management institutions and system resilience are key determinants of adaptive management success. Managing to rebuild overfished species populations is fraught with uncertainty because of the difficulty in predicting future performance. Stock performance depends on the nature of ecosystem resilience. As first described by Holling (1973), resilience may either be interpreted as a return to some "global" equilibrium following perturbation (such as fishing down one population in the system) or in terms of multiple equilibria where future states are unpredictable. For example, the role environmental regimes play in determining recruitment is at best poorly understood, which limits the accuracy of unfished biomass estimates. This limits managers' ability to realistically plan for a future end state of stock recovery. Policy makers may be tempted to replace ecosystem uncertainty with "spurious certitude": "Perhaps the most common solution is to replace the uncertainty of resource issues with the certainty of a process, whether that process is a legal vehicle—such as a new policy, regulation, or lawsuit (Rodger 1997)—or a new institution—such as a technical oversight committee or science advisory committee" (Gunderson 1999, p. 2). Given the long time horizons involved in rebuilding some overfished groundfish populations, uncertainty about future stock performance, and uncertainty about ecosystem performance, a flexible, or adaptive, management regime will be important.

Nyberg (1999) outlines six steps in the adaptive management cycle. (Other authors have posited similar steps (c.f. Olsen 1993).). Rebuilding mandates and the institutional structure of federal fisheries management (including the Council system) provide all the "pieces" to construct these steps: problem identification, program design, implementation, monitoring, evaluation, and adjustment of the management regime, which initiates a new round in the cycle of steps just described. Monitoring and evaluation are the key steps differentiating adaptive management; and flexibility—which makes the regime easier to change in response to new information—is a valuable attribute in these steps. The scenarios presented in this analysis all incorporate procedures to update rebuilding plans, and adjust management measures, in response to new information about overfished stocks. For all scenarios, flexibility of response is constrained by the range of management tools that are both legal and practical. What varies is the procedural complexity entailed in adapting management measures in response to new data. This is a correlate of administrative cost discussed above. More complex procedures will require more administrative resources. (On the other hand, they may force better problem assessment and redesign as part of the adaptive cycle.) Generally, then, flexibility and administrative cost are inversely correlated.

Groundfish management rests on a framework described in the FMP, which allows management targets (OY levels for managed species) to be specified annually, based on regular stock assessments. A range of management measures are then available, which also can be modified annually, in order to constrain fisheries to these targets. (As discussed below, groundfish management is shifting to a two-year cycle.) The adoption of rebuilding plans establish longer term targets for overfished stocks. More generally, the management framework establishes a target biomass, B_{MSY}, and according to the "40-10 rule" even stocks above the overfished threshold but below target biomass are subject to precautionary management. In the rebuilding analyses, the P_{MAX} value is used to determine the fishing mortality rate (F) that is estimated to allow the stock to rebuild to the target given that probability and T_{TARGET} defined as the median rebuilding year. This F is then applied to current estimates of stock size to arrive at its OY or current-year management target. This process allows adaptive management over the longer term because annual targets are tied to a probability-based measure of stock recovery.

The management process is subdivided into two components: developing scientific information and making management recommendations. Stock assessments (and rebuilding analyses) are science driven. They arrive at an estimate of a sustainable yield for a stock (OY) within the management framework. Because of scientific uncertainty, stock assessment results may be presented as a range of values, providing policymakers with an implicit or explicit (as in the case of rebuilding analyses) tradeoff between risk and short-term benefits. The results of this scientifically driven part of the process are then used by the Council in their policymaking capacity. In addition to risk/benefit tradeoffs, the Council also considers the allocation of fishing opportunity and formulates the management measures intended to achieve scientifically-determined targets. The next three subsections describe stock assessments, rebuilding analyses, and Council decision-making.

3.1.2.1 The Stock Assessment Process

Stock assessments for Pacific Coast groundfish are generally conducted by staff scientists of California Department of Fish and Game, Oregon Department of Fish and Wildlife, Washington Department of Fish and

Wildlife, Oregon State University, University of Washington, and the NMFS Southwest, Northwest, and Alaska Fisheries Science Centers. These assessments describe the condition or status of a particular stock and report on its health. This allows biologically sustainable harvest levels to be forecast; scientists can then make management recommendations to maintain or restore the stock. If a stock is determined to be overfished (less than 25% of its unfished biomass), a rebuilding analysis and a rebuilding plan are developed.

For more than 20 years, groundfish assessments have primarily been concentrated on important commercial and recreational species. These species account for most of the historical catch and have been the targets of fishery monitoring and resource survey programs that provide basic information for quantitative stock assessments. However, not all groundfish assessments use the same level of information and precision.

Quantitative and nonquantitative assessments are used for groundfish stocks. For stocks that are assessed quantitatively, scientists use life history data to build a biologically realistic model of the fish stock for these stock assessments; they then calibrate the model so that it reproduces the observed fishery and survey data as closely as possible. Recently similar, but more powerful, models using state-of- the-art software tools have been developed. Assessment models and results are independently reviewed by the Council's Stock Assessment Review (STAR) Panels. It is the responsibility of the STAR Panels to review draft stock assessment documents and relevant information to determine if they use the available scientific data effectively to provide an accurate assessment of the condition of the stock. In addition, the STAR Panels review the assessment documents to ensure that they are sufficiently complete and the research needed to improve assessments in the future is identified. The STAR process is a key element in an overall process designed to make timely use of new fishery and survey data, to analyze and understand these data as completely as possible, to provide opportunity for public comment, and to assure the assessment results are as accurate and error-free as possible.

Following review of assessment models by the STAR Panels, and subsequently the GMT and SSC, the GMT uses the reviewed assessments to recommend preliminary ABCs and OYs to the Council. The SSC comments on the STAR review results and the GMT recommendations. Biomass estimates from an assessment may be for a single year or an the average of the current and several future years. In general, an ABC will be calculated by applying the appropriate harvest policy (MSY proxy) to the best estimate of current biomass. ABCs based on quantitative assessments remain in effect until revised by either a full or partial assessment.

Full assessments provide information on the abundance of the stock relative to historical and target levels, and provide information on current potential yield. Scientists conduct partial assessments when they do not have enough data for a full assessment. Even full assessments can vary widely in reliability because of the amount of data available for modeling. Council-affiliated scientists conduct several assessments each year. Individual stocks may be periodically reassessed as often as every year—currently only the case for Pacific whiting—to every two to four years. However, because of limits on scientific staff and data availability, some species have been assessed only once.

Stocks with ABCs set by non-quantitative assessments typically do not have a recent, quantitative assessment, but there may be a previous assessment or some indicators of the status of the stock. Detailed biological information is not routinely available for these stocks, and ABC levels have typically been established on the basis of average historical landings. Typically, the spawning biomass, level of recruitment, or the current fishing mortality rates are unknown.

Many species have never been assessed and lack the data necessary to conduct even a qualitative assessment, such as a general indication in biomass trend. ABC values have been established for only about 26 stocks. The remaining species are incidentally landed and usually are not listed separately on fish landing receipts. Information from fishery-independent surveys are often lacking for these stocks, because of their low abundance or invulnerability to survey sampling gear. Precautionary measures continue to be taken when setting harvest levels (the OYs) for species that have no or only rudimentary assessments. Since implementation of the 2000 specifications, ABCs have been reduced by 25% to set OYs for species with less rigorous stock assessments, and by 50% to set OYs for those species with no stock assessment. At-sea observer data will be available for use in the near future to upgrade the assessment capability or evaluate overfishing potential of these stocks.

3.1.2.2 Rebuilding Analyses

In the case of overfished species, stock assessment results form the basis of a rebuilding analysis, which in turn is used to develop rebuilding policies and choose the rebuilding target identified in each rebuilding plan. The elements of rebuilding analyses are described in the SSC Terms of Reference for Rebuilding Analyses (SSC 2001). This guidance has been incorporated into a computer program for conducting rebuilding analyses (Punt 2002b). In the analysis the probability the overfished stock will reach the target biomass defining a rebuilt stock (B_{MSY} or $B_{40\%}$) is determined in the absence of fishing (T_{MIN}) and the maximum permissible rebuilding time under National Standard Guidelines (T_{MAX}). The target rebuilding year (T_{TARGET}) is determined based on these limits and the probability of achieving the target biomass by T_{MAX} (denoted P_{MAX}). Probability statements are an estimate that something may happen (in this case, that stocks will reach a given size in a specified time period) and thus also the level of risk associated with a given action. When interpreting rebuilding analyses it is important to understand how probability statements are derived, distinguish the basic policy choice from those parameters determined by national policy, identify different sources of uncertainty, and appreciate that even “fixed” values can change as the system (or fish stock)—and our understanding of it—change over time.

The rebuilding analysis program uses “Monte Carlo simulation” to derive a probability estimate for a given rebuilding strategy. This method projects population growth many times in separate simulations. It accounts for one source of uncertainty about future stock status by randomly choosing the value of a key variable—in this case total recruitment or recruits per spawner—from a range of values. These values can be specified empirically, by listing some set of historical values, or by a relationship based on a model. The SSC recommends the rebuilding analyses use historical values. Because of this variability in a key input value, each individual simulation, or “case,” will show a different pattern of population growth. As a result, a modeled population may reach the target biomass in a different year in each of the cases in the Monte Carlo simulation. Figures 3-1 shows the results of five such cases from a hypothetical rebuilding analysis. (The values do not represent any of the actually overfished species.) The horizontal line at 0.4 represents target biomass. It can be seen that population increases steadily in each case, but at a different rate because of differences in the number of recruits in each future year for each case. Case #1 reaches the target biomass soonest, in 2025, while case #5 takes the longest, reaching the target in 2048.

The number of cases that reach the target biomass in any year can be computed and these values cumulated, or successively added together, starting with the first year set for the simulation and running out to some maximum number of years (which could be the case in which the population took the longest time to reach the target biomass or a predetermined maximum value). This cumulative probability shows the number of cases that have reached the target biomass in all the years up to and including the specified year, which is also an estimate of the probability the stock will rebuild by that year.

Figure 3-2 illustrates this concept of cumulative probability. The percent of simulations reaching the target biomass in each year, for some specified fishing mortality rate, is represented by the vertical bars. The five cases shown in the previous figure are plotted along with the other 995 cases that are part of this Monte Carlo simulation. The years in which the five cases in the previous figure reached the target biomass are highlighted in this figure. Case #3, for example, along with 26 other cases (that weren’t plotted in the first figure), make up the bar tallying the number of cases rebuilt in 2032. The ascending solid line sums simulations that have reached the target biomass in any of the preceding years, even if biomass declines below the target in subsequent years. This ascending line represents the rebuilding probability. (It is important to note the calculated cumulative probability includes cases reaching the target biomass in any previous year. Species with highly variable recruitment may achieve the target biomass and subsequently fall below it, even in the absence of fishing. If these cases were excluded, the probability of recovery in any given year would likely be lower, depending on species being modeled.)

This technique can be used first to calculate T_{MIN} in probabilistic terms, which is defined as the time needed to reach the target biomass in the absence of fishing with a 50% probability. (It may be said that the 50% value represents “even odds”; it is equally likely the stock has rebuilt or not rebuilt in this year. In all other years it is either more or less likely the stock has rebuilt.) Thus, in a Monte Carlo simulation with 1,000 cases where the fishing mortality rate (F) is set to 0, the number of cases reaching the target biomass in a given year can be cumulated. In Figure 3-3 T_{MIN} is determined by finding the year in which this cumulative value equals

500 (or 50%). In other words, in half the simulations the target biomass was reached in some year up to and including the computed T_{MIN}. Given T_{MIN}, and assuming that it is greater than or equal to ten years (as is the case with most of the overfished groundfish stocks), T_{MAX} is computed by adding the value of one mean generation time. Figure 3-3 shows a T_{MIN} of 15 years (or 2014 if the stock were declared overfished in 1999). A mean generation time of 17 years is added to compute T_{MAX}.

After determining T_{MAX}, multiple Monte Carlo simulations are conducted, varying the fishing mortality rate. This determines the relationship between F and the probability of the stock being rebuilt by T_{MAX}, which is P_{MAX}. Figure 3-4 displays the results of three hypothetical simulations for fishing mortality rates resulting in P_{MAX} values of 90%, 70% and 50% (the minimum permissible rebuilding probability). Since a higher P_{MAX} probability must be achieved by lowering the fishing mortality rate (other things being equal) there is a tradeoff between fishery harvests and rebuilding speed in probabilistic terms. As we reduce fishing, the likelihood the stock will recover in this maximum time period increases.

Once probability distributions have been computed, like those plotted in Figure 3-4, a corresponding T_{TARGET} can be determined for distributions representing different harvest rates (F) and corresponding P_{MAX} values. T_{TARGET} is defined as the median year in each probability distribution, which is simply the year by which half of all cases have already rebuilt, and is unique for a given F and P_{MAX}. Figure 3-4 shows how this is computed for the three plotted fishing mortality rates and corresponding P_{MAX} probabilities. As expected, if we apply the lowest of the three plotted fishing mortality rates (in other words, limit fishing the most), the stock will rebuild the fastest (or more accurately, has the highest probability of rebuilding by T_{MAX}). The target year for the lowest fishing mortality is 25 years. (To determine the actual target year, we add this value to the year in which the stock was declared overfished. Continuing with the example above, if the stock was declared overfished in 1999, then the target year is 2024.) Not surprisingly, this strategy also results in the highest P_{MAX}, equal to 90%. The fishing mortality rate associated with the 70% P_{MAX} value gives a later target year: 2028. Finally, T_{TARGET} equals T_{MAX} for the highest allowable fishing since the P_{MAX} value—50%—is the same probability used to determine T_{TARGET}.

From a policymaking standpoint, the essential tradeoff is between a given level of fishing mortality and the probability the stock will be rebuilt within the maximum permissible time period (P_{MAX}), and the related target year. Although computationally there is a prescribed relationship, with P_{MAX} as an input value, policymakers may wish to base their decisions on F, as expressed in the harvest control rule or simply choose a given target year and determine from it the associated P_{MAX} and F. Figure 3-5, taken from the canary rockfish rebuilding analysis, illustrates this tradeoff. It shows the relationship between any OY level in the current year, P_{MAX} and T_{TARGET}.

As the preceding discussion suggests, probability statements about T_{MAX} tell us the likelihood of an outcome based on our understanding of a fish stock and our ability to model how that stock will grow over time. Since our understanding of these population characteristics is imperfect, some sources of uncertainty are not captured in the aforementioned probability statements. First, inputs to the rebuilding analysis are to a greater or lesser degree best estimates of true values. This applies to basic biological parameters, such as fecundity, that are used to model population growth. Population projections also depend on an estimate of the size and age structure of the modeled stock at the outset of the projected time period, derived from the most recent stock assessment. Similarly, the biomass target ($B_{40\%}$) requires an estimate of the equilibrium population size that would be reached in the absence of fishing (see below). In all these cases the best estimate may not coincide with the true value. The Monte Carlo simulation used in the rebuilding analyses only considers uncertainty about future recruitment, so inaccuracy in the estimation of both species and stock-specific variables will not be captured in resulting probability statements. Finally, there is some uncertainty (or variability) inherent to the Monte Carlo simulation because any one simulation will not include all possible outcomes (or cases). This variability can be assessed by performing several simulations and measuring the variation in the output value (fishing mortality for a given T_{MAX} probability) among these simulations (Punt

2002a). This type of assessment can be used to establish a range around a point estimate (the mean value) expressing the likelihood the true value falls within that range.[8/]

New information may result in new estimates of biological and stock parameters, and assessed uncertainty in the Monte Carlo simulation tells us something about the range of possible outcomes. But rebuilding trajectories will also change over time with new stock assessments and as historical data (such as total catch estimates for past years) replace projected values. The time limits and target—T_{MIN}, T_{MAX}, and T_{TARGET}—fall along a time scale that begins when the stock is declared overfished (y_{DECL}).[9/] Because the rebuilding analysis is usually conducted from one to several years after y_{DECL}, a more recent stock assessment may allow population growth to be projected from the most recent year for which stock structure data (such as mortality, weight, and number of animals for each age class in the population) are available. In subsequent analyses (conducted as new stock assessment data become available), the pool of historical recruitment values will likely differ (with addition of the most recent years' data) and the there will be fewer years for which population growth is projected. (This assumes that T_{MAX} is not re-computed because, for example, changes in stock structure produce a different value for mean generation time.) It is highly likely the new analysis will suggest a different level of fishing mortality to achieve the same P_{MAX} and by extension T_{TARGET}. Conversely, if the policymaker wishes to continue with the same harvest policy—a given fishing mortality rate for example—P_{MAX} and T_{TARGET} would likely be different in the new analysis.

Estimation of Unfished Biomass

Target biomass is directly related to B_0, or unfished biomass. (It is expressed as a percentage of this value.) Target biomass in turn affects the rebuilding trajectory described by T_{MIN}, T_{MAX}, and T_{TARGET}. B_0 is rarely known absolutely; instead, it is calculated based on the relationship between the number of spawning fish and resulting recruits to the fishable population. Modelers choose a time period for which data are available and fishing effort has been at a stable and relatively moderate level. However, biologists are not sure of how important environmental conditions are to survival and growth, versus spawning population size. (A hypothesis favoring spawning population size as the determinant of recruitment is called a "density dependent" spawner to recruitment relationship. For groundfish this relationship is believed to be positive: a larger spawning population results in greater total recruitment.) These considerations complicate the choice of the time period used as basis for unfished biomass computations. For Pacific Coast groundfish these two factors have historically had potentially confounding effects. A large-scale regime shift began in 1977; many scientists believe that generally warmer water produced less favorable conditions for groundfish (Hare and Mantua 2000). The period after 1977 also saw a decline in groundfish populations due to increased fishing effort. If an environmental explanation is favored, one would choose a long time series that encompassed recruitment both before and after 1977 in order to account for the impact of the environmental change. However, this will result in a relatively lower value for B_0 than only using recruitment values before 1977 when biomass and recruitment were closer to an unfished state. The SSC also discussed a third approach in its Terms of Reference (SSC 2001), using spawner-recruit models instead of relying solely on empirical data. These models are problematic because they mathematically presuppose a certain spawner-recruit relationship. The overfished species being modeled may not exhibit this relationship because of its particular biology and ecology. The SSC recommended determining B_0 based on the density-dependent hypothesis and, therefore,

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[8/] These assessments demonstrates three important points. First, different modeled species will produce different degrees of variability when comparing Monte Carlo simulations because of the underlying variability in the input recruitment data. Second, for a given species and P_{MAX} increasing the number of cases in a simulations decreases uncertainty (or relative variability). But this decrease is not constant; increasing the number of cases in a simulation beyond a certain number produces diminishing returns in terms of reducing uncertainty. Finally, for a given species and number of cases in the Monte Carol simulation, choosing a lower P_{MAX} increases certainty (by decreasing the range of possibly "correct" values for fishing mortality, or OY).

[9/] National Standard guidelines identify the initial rebuilding year, for the purpose of calculating targets, as the year in which rebuilding measures were first implemented. For overfished Pacific groundfish this would be the year in which interim rebuilding plan measures were implemented as part of the annual management process. In most cases this was the either y_{DECL} or the following year.

using earlier data (resulting in relatively large values for B_0). Although, as discussed above, the determination of B_0 is not a policy choice, its value does influence policy choices since other parameters, such as target biomass, are defined in relation to B_0.

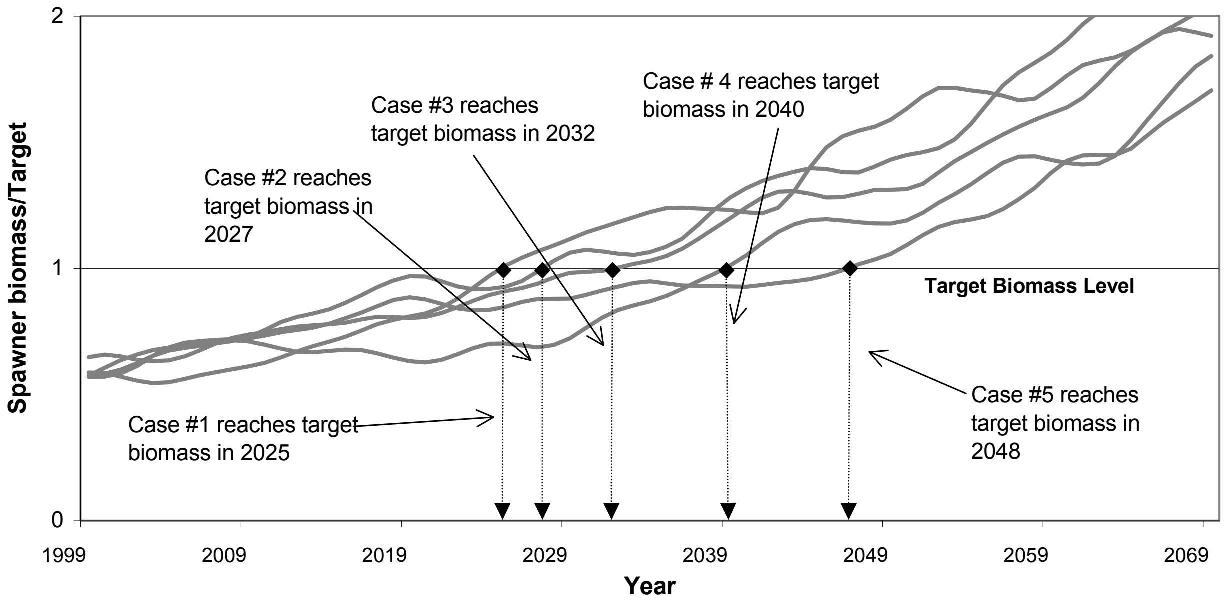

FIGURE 3-1. Example of five cases from a Monte Carlo simulation.

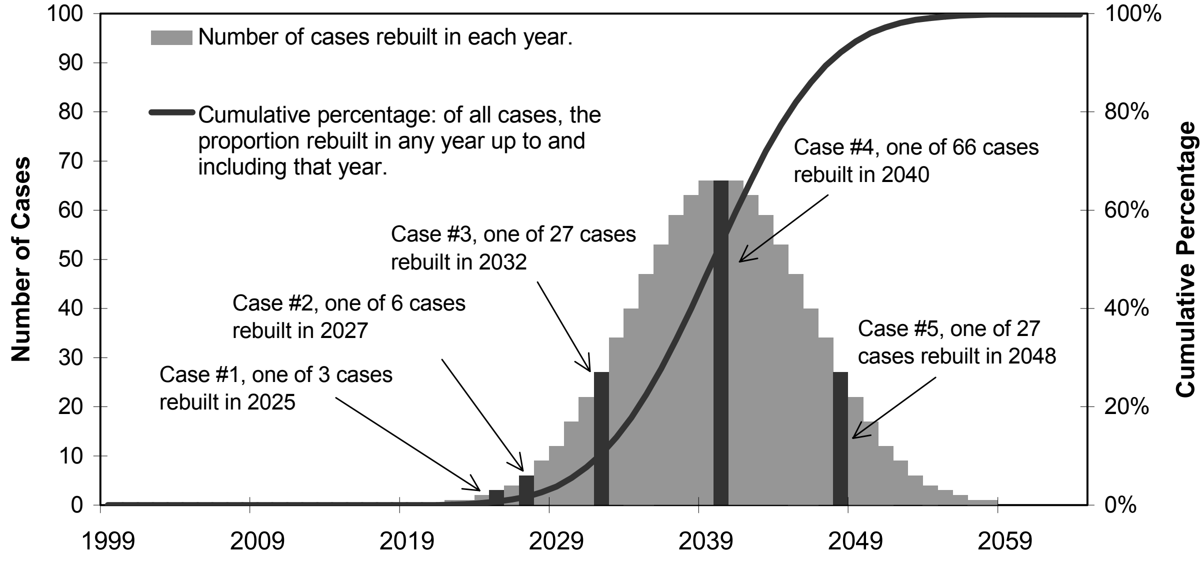

FIGURE 3-2. How cumulative probability is calculated in a Monte Carlo simulation.

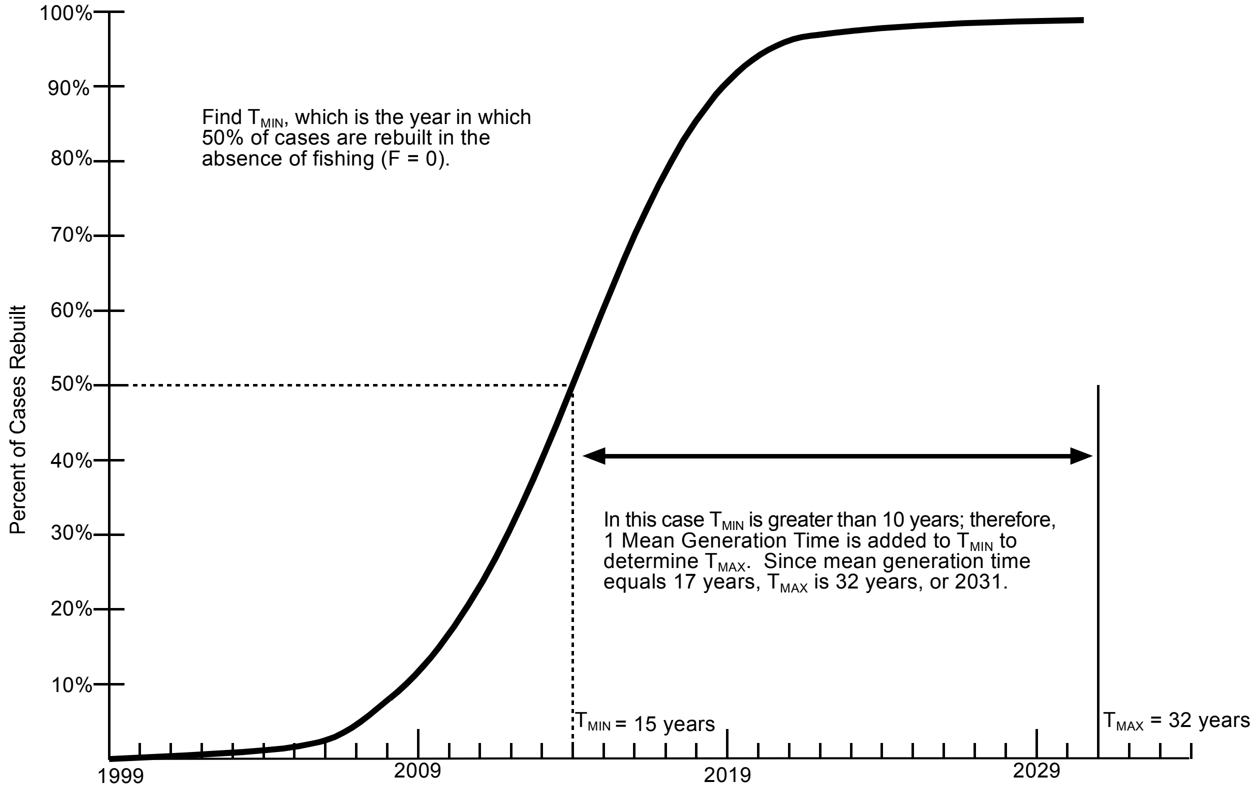

FIGURE 3-3. Calculation of the minimum rebuilding time, T_{MIN}.

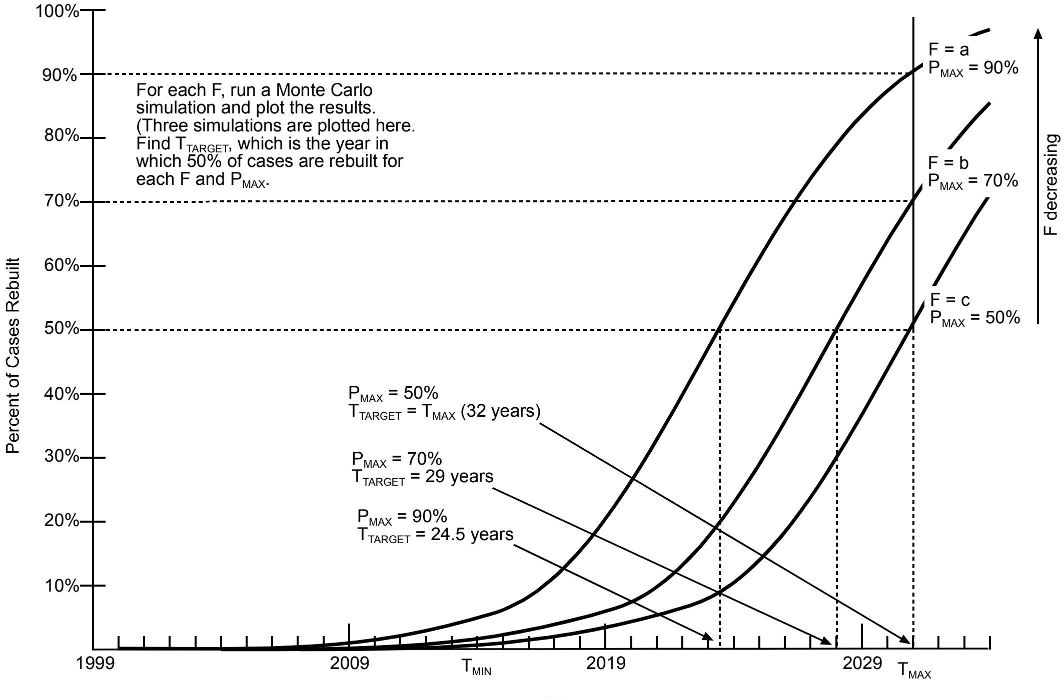

FIGURE 3-4. Computation of the rebuilding probability (P_{MAX}) and the median rebuilding year (T_{TARGET}).

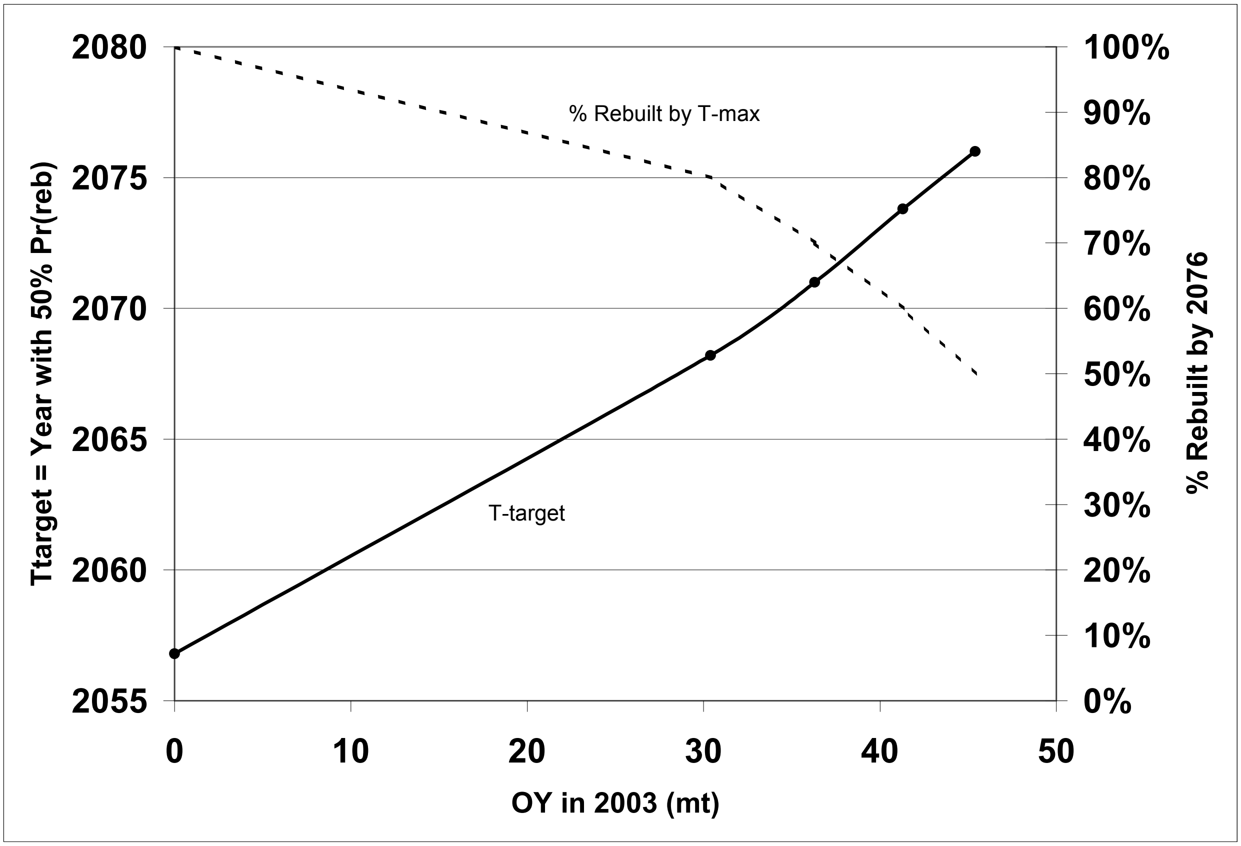

FIGURE 3-5. Tradeoff between OY in 2003, T_{TARGET} and T_{MAX} from the canary rockfish rebuilding analysis (Methot and Piner 2002).

3.1.2.3 Council Decision-making

Periodic Management

Groundfish management is mainly implemented through a framework in the FMP, which allows the Council to recommend new fishing regulations, as long as these measures fall within the range of the principles and policies described in the FMP. Section 6.2 in the groundfish FMP also describes different procedures for establishing and adjusting management measures. To date, this type of "seasonal" management has been implemented through regulations promulgated annually, covering a fishing year, which corresponds to the calendar year. This process requires at least two Council meetings followed by notice and comment rulemaking. Notice and comment rulemaking requires publication of a proposed rule in the *Federal Register* commencing a 30-day public comment period, followed by publication of the final rule, with any modifications stemming from public comment. Once this process is completed, regulations may come into effect. To change rebuilding measures incorporated into regulations this full rulemaking process would be followed. Other actions, such as inseason management changes, may be implemented through more abbreviated processes. But under the options outlined under Issue 1 in this EA (see Section 2.1.1), these procedures would not be applicable to rebuilding measures. As noted in Chapter 2, the same notice and comment rulemaking process used to implement periodic management could be used to change the rebuilding strategy and implement rebuilding measures.

In November 2002, the Council approved Amendment 17 to the groundfish FMP, changing the process for developing groundfish specifications and management measures so that measures could be established for two years, rather than one year. This will provide more time for the Council and NMFS to work on other critical groundfish issues. This schedule also allows enough time for NMFS to publish a proposed rule in the *Federal Register* and take public comment before its final decision on whether to approve the Council recommendations. Because of limited amount of time between a final Council decision and the beginning of the new fishing year, and a lawsuit requiring NMFS to use notice and comment rulemaking, the agency had to implement an emergency rule for the first two months of 2003. This allowed the fishing season to commence while comment continued on the final rule for the rest of the fishing season (March-December). Promulgating both rules results in a procedurally complex and administratively burdensome process. The difficulty of an annual process is compounded by the fishing industry's strong desire the fishing season correspond to the full calendar year in order to assure consistent supply to processors and markets. As management becomes more complex, there is not enough time in a one-year cycle to complete all of the required components, starting with completed stock assessments and ending with annual regulations. In recent years management measures (primarily bag limits and seasons) have also been applied to recreational fisheries, adding to this complexity.

The Council's preferred alternative for Amendment 17 (subject to approval by the Secretary) would establish a biennial management cycle for groundfish, beginning with the 2005-2006 fishing years. Under this alternative, a three Council meeting (November-March/April-June) process would be used to prepare biennial management measures. OY values for managed species would be established for each fishing year during this two-year management period. That is, two one-year OYs would be specified for each managed species.

To ensure the Council could respond to significant changes in a fishery, the Council also included in Amendment 17 a process for reviewing fishing levels during the multi-year management period to ensure sufficiently conservative harvest levels in order to protect and rebuild overfished species. These checkpoints would consider whether new science or assessment information should be used to alter harvest levels. The Council asked the GMT (in consultation with the SSC and GAP) to develop thresholds for determining whether mid-process changes are necessary.

FMP Amendments

Annual management allows adaptation to short-term changes in the status of stocks and the fisheries exploiting them (tied to long-term targets in the case of stocks below the target biomass). Broader changes to the management regime require FMP amendments. (Regulations also may be amended to effect such a change. Generally speaking, the FMP governs the management regime while regulations specify public conduct—in this case, what fishermen may or may not do.) Council Operating Procedure 11 describes the process for amending the FMP (PFMC 2000). An issue identified by advisory bodies or the public is taken up at the first meeting where the need for action is considered along with possible alternatives. A draft amendment package is then prepared for Council review at a second meeting. During this meeting the Council selects a preferred alternative, if possible, and adopts the draft amendment for public review. Staff then prepare a final draft amendment, which is made available for public comment. Public hearings are held during a third Council meeting and the Council adopts the final amendment for implementation by the Secretary. After the third meeting, Council staff make any needed non-substantive additions and changes and transmit the document to NMFS for review. The Secretary may then disapprove, approve or partially approve the amendment. If disapproved or partially approved, the Council may revise the proposal, addressing concerns raised by the Secretary, and resubmit the amendment. Given this process, aside from any staff time needed to prepare the analyses and supporting documentation, Council decision-making can take six to eight months. This is the minimum time within which three meetings could occur given the Council meeting schedule (bearing in mind that groundfish issues are usually kept off the agenda during the Council's March meeting). For example, about six month would elapse if initial consideration occurred at the April meeting, then the June and September meetings were used to complete the process. Of course, the Council may not be able to consider an action during three successive meetings because of the total time available for the meeting agenda or because requisite document drafts are incomplete. This would lengthen the schedule still further. Additional time is also needed after the Council's final decision to prepare the NEPA document submitted to NMFS to start the agency review process, which results in implementation if the amendment is approved.

3.1.3 Public Participation

An often-cited work on citizen participation (Arnstein 1969) proposes an eight-rung “ladder of participation” (see Figure 3-6). The lowest two rungs represent nonparticipation; public involvement is a means for the organization to persuade or manipulate the public. The next three rungs represent different levels of “tokenism”; an organization may offer opportunities for the public to comment, or express their views on a decision, but there is no guarantee their concerns will be heeded by decision-makers. The last three rungs represent successively higher degrees of true citizen power, to the degree that they have either delegated decision-making authority or actual control over the process. The Council process lies somewhere on the upper rungs of what Arnstein labels tokenism or at the lowest rung of citizen power, labeled partnership (citizens can negotiate with power-holders but do not have ultimate authority). It is also worth mentioning the large body of literature on common property resource institutions (see Ostrom *et al.* 2002 for a recent review), if for no other reason than Arnstein's typology begs the question of what constitutes the potentially enfranchised public. This literature is concerned with arrangements for controlling access to and use of resources that are not privately held. From this perspective “citizen involvement” may be cast in terms of such arrangements and correlated institutions. Fishers—those directly exploiting the resource either commercially or recreationally—tend to be more active in the Council process because of their activities may be directly affected. The broader public, represented to some degree by different environmental groups, have a more diffuse interest in the marine ecosystem and the array of nonextractive or nonmonetary benefits derived from it.

The Council process offers range of forums for public participation, related to Arnstein's ladder of participation. Council members membership is meant to represent a range of stakeholders (although some argue that representation is insufficiently diverse). The GAP reflects the perceptions and opinions of representatives of industry, recreationalists and other constituents on the committee; consensus statements from this body can directly influence Council members’ decisions. (Technical bodies, such as the GMT and SSC similarly promote consensus on scientific issues.) Meetings of these bodies are open to the public, allowing limited participation by nonmembers and, at a minimum, public scrutiny of discussion and decisions. Comments from the public at large, through letters to the Council in advance of meetings and during comment periods at meetings can be collectively influential. The public also has the chance to lobby members of advisory bodies and the Council during meetings, but outside established, formal public comment periods. Once the Council passes on its decisions to NMFS, as recommendations, there are opportunities for the submission of written comments during the rulemaking process. The most visible, and formalized, venues for public participation through commenting are associated with decision-making (either by the Council or NMFS). More complex decision processes (for example, involving multiple stages of review and revision by advisory bodies and the Council) generally afford more opportunity for public comment.

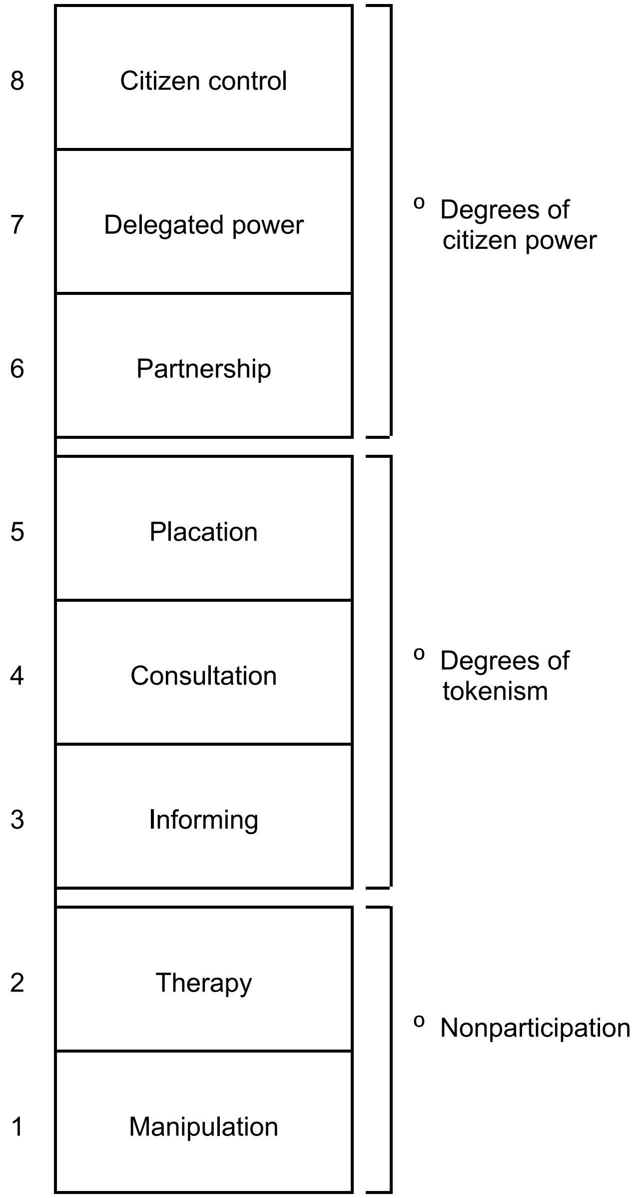

FIGURE 3-6. Levels of citizen participation (Arnstein 1969, p. 217).

Trust is an important corollary of public participation that can play out in a variety of ways. Interest groups and stakeholders who believe they have some influence over decisions are likely to put greater trust in the process. By reducing conflict, influence can stem controversy. (It should be emphasized that in the policy arena conflict and controversy are not necessarily bad things. They force more careful consideration of an issue from different perspectives. This may result in more equitable decisions.) On the other hand, those groups who believe themselves lacking in influence will seek greater transparency and certitude. Transparency allows the public to determine what factors (especially those that are explicitly “political”) influence decision-making. Certitude reassures those with less influence that decisions are constrained by explicit rules limiting their scope. Constraints may be external—imposed by legal requirements for example—or self-imposed so that a course of action is fully or permanently determined. As implied in the previous discussion of adaptive management, this type of certitude can be an institutional response to uncertainty, and one that runs counter to adaptive response. This is especially the case if interest groups see uncertainty as a means for specific groups with opposing interests to unduly influence decision-making. This may be an important factor in relation to rebuilding measures because of the high degree of uncertainty about stock status in the future. Uncertainty could be seen to enlarge the range of potentially defensible decisions.

Similarly, invoking adaptative strategies might be seen as an opportunity to accommodate a given set of interests. This aspect of participation, as it relates to controversy, is also evaluated by assessing “certitude,” or the degree to which decisions are constrained by established policies. (These are constraints over and above those established by the Magnuson-Stevens Act and National Standard Guidelines.) This characteristic will also tend to vary inversely with flexibility (adaptability).

3.2 Evaluation of Rebuilding Strategies

As discussed in Chapter 2 and section 3.1.2.2, the different parameters used to characterize rebuilding can be assigned to different categories. First, there are biological parameters that describe the underlying characteristics of the stock. Unfished biomass, and by extension the target biomass, and mean generation time fall into this category. Second, there are the two limits—T_{MIN} and T_{MAX}—established by national policy, which denote the minimum possible and maximum allowable rebuilding times. None of these parameters represent a policy choice available to the Council. Finally, there are the strategic parameters, which, along with any adopted management measures, represent a rebuilding strategy. These parameters are F (or a specified harvest control rule), P_{MAX} and T_{TARGET}. As discussed in Chapter 2, the Council may choose any one of these three values as the basis for their rebuilding strategy, although T_{TARGET} needs to be specified in order to comply with language in the Magnuson-Stevens Act. At the request of Council staff, Dr. Andre Punt of the University of Washington School of Fisheries and Aquatic Sciences simulated results of holding any one of these values constant (i.e., using it as the basis for the management strategy) as new stock assessments add new information about recruitment.

The simulation assumes that stock assessment scientists have perfect information about the current age-structure of the population, historical spawning biomass (including the unfished spawning biomass), and historical recruitment. Thus, biological and national policy parameters do not change. Although this is unlikely to be the case, it allows the analysis to focus on the tradeoffs of using different strategic parameters. The simulations assume, however, the stock assessment scientists do not know the stock-recruitment relationship (and hence future recruitment), and must therefore predict future recruitment by assuming the ratio of the number of recruits to spawning biomass size is a constant value. Put another way, there is a true relationship between population size and structure and recruitment, but scientists do not know the parameters for this relationship. Instead, stock assessment scientists use a model representing their current (and incomplete) understanding of the truth.

New recruitment values are added to the projection every three years, mimicking the availability of new estimates from a typical stock assessment cycle (which in reality can vary between two and four years for groundfish). For the simulations where it is held constant, P_{MAX} is set at arbitrarily at 60%. T_{TARGET}—the median rebuilding year for this P_{MAX}—is calculated to be 86 years. (The simulation begins in year 44 of a rebuilding period with a T_{MAX} of 91 years). The F calculated for the initial three years of the simulated period is used to simulate a constant F strategy. In order words, the calculations are based on setting P_{MAX}, T_{TARGET} or F when the first rebuilding analysis is done and not changing the specified value thereafter.

3.2.1 A Constant F Versus Constant T_{TARGET} Strategy

Figures 3-7 through 3-9 display the results of these simulations. Figure 3-7 displays projected population growth under each strategy. Figures 3-8a and 3-8b show the effects of the different strategies on OY and F, respectively. Figures 3-9a and 3-9b show the effects of the different strategies on T_{TARGET} and P_{MAX}. Looking at all of the figures it can be seen that no matter what parameter is held constant the relationship between P_{MAX} and T_{TARGET} does not differ by much. This is reflected in the fact the lines representing these two parameters (dashed or dot-dashed) substantially overlap. In terms of rebuilding strategy, therefore, the essential tradeoff is between managing to a constant F (putting strategic emphasis on the harvest control rule) or T_{TARGET} (as determined for a given P_{MAX}). As seen in Figure 3-7, holding F constant, based on stock condition at the outset of the simulated period, results in faster rebuilding to the target biomass. Larger increments of the population are not removed by fishing as it reaches the target size; as a result, in this simulation at least, the population reaches its target size well before T_{MAX} and continues growing. A constant T_{TARGET} strategy allows F to increase as population approaches the target biomass, based on the 60% probability of achieving it within 91 years (T_{MAX}).

Figure 3-7a shows the effect on annual OYs. Under a constant T_{TARGET} strategy larger biomass increments are removed as the population increases, resulting in the steady increase in OYs seen in Figure 3-8a. OYs are also more variable since F is adjusted up or down in response to changes in recruitment. Figure 3-8b is similar, displaying the change in F, rather than OYs. The horizontal solid line in this figure represents the value of F under a constant F strategy. (By definition, a constant value results in a horizontal line.) A T_{TARGET} (or P_{MAX}) strategy allows F to increase so that a larger fraction of the stock is taken, resulting in decreasing population growth rates as the biomass target nears. The stair-step appearance of F under a constant T_{TARGET} (or P_{MAX}) strategy in this figure simply reflects the fact the same newly computed F is applied during each year in each successive three-year period after a stock assessment. In both figures it can be seen that F, and the resulting OY, have to be adjusted downward after some assessments due to modeled variability in recruitment.

Figures 3-9a and 3-9b show the same relationships in terms of T_{TARGET} and P_{MAX} respectively. In Figure 3-9a the solid line shows the estimate of the target year is successively lowered under a constant F strategy. Estimates of T_{TARGET} under a constant P_{MAX} strategy differ little from the initially computed value. In Figure 3-9b the solid line simply shows that under a constant F strategy P_{MAX} rapidly reaches 100%, because the target biomass is reached much sooner. Again, the relationship between P_{MAX} and T_{TARGET} (represented by the difference between the dot-dashed and dashed lines) varies only slightly due to modifications in recruitment values used in the projections.

In summary, assuming perfect information, there is no scientific basis for favoring one rebuilding strategy over the other. However, they have different implications from a policy perspective. A constant F strategy results in faster rebuilding and more stable OYs year to year. But over time these OYs remain lower than under a constant T_{TARGET} strategy, at least until the stock reaches its target biomass when the MSY harvest rate can be applied. Under the T_{TARGET} strategy, F is adjusted after every assessment so the target biomass will be reached in the target year (with a 50% probability, since it is defined as the median year for any P_{MAX} probability distribution). As a result, OYs will increase as F is readjusted, as long as the population grows, but—by definition—this strategy aims to restore the stock to its target biomass by the target year and not at any earlier date. By the same token, F (and resulting OYs) are adjusted downward in response to reduced recruitment.

3.2.2 Implications of Rebuilding Analysis Input Estimation Errors

As noted above, this simulation assumes perfect information about the input values for the analysis. In some cases stock productivity may be under- or over-estimated, as revealed by subsequent assessments. Obviously, over-estimating productivity for some period of time would have graver consequences than under-estimating it. The current status of bocaccio rockfish offers an instructive, although extreme example of the effect of estimation errors. This species was declared overfished in 1999. In subsequent years recruitment was thought to have been over-estimated resulting in too-high harvest limits, which were then exceeded. In addition, a change in the way rebuilding analyses are structured had an important effect on rebuilding prospects. Previously, T_{MIN} was recalculated starting from the year in which the rebuilding analysis was conducted. The analysis was revised to fix the starting point for the analysis at the year when the stock was declared overfished (in this case 1999) and account for actual harvests in subsequent years up until the year when the analysis is performed. As a result, a revised 2002 rebuilding analysis (MacCall and He 2002), accounting for the over-harvest in the intervening years, shows that even in the absence of fishing P_{MAX} is less than 50%. This is because the limits (T_{MIN} and T_{MAX}) were calculated based on existing recruitment data while the P_{MAX} calculation accounts for the excessive harvests.

A subsequent rebuilding analysis (MacCall 2003) presents a very different picture. A large 2002 year class had been suspected, and the earlier assessments and rebuilding analyses even anticipated its contribution to population productivity. However, no hard data revealing the strength of this “recruitment pulse” was available to include in the 2002 stock assessment and rebuilding analysis, contributing to their pessimistic results. By the time of the 2003 assessment, however, substantive data on the 1999 year class were available. This has resulted in much higher OYs for the same set of rebuilding parameters, a range between 178 and 674 mt for 2004. The 2002 rebuilding analysis appears to have under-estimated recruitment, producing an OY that, in retrospect, was unnecessarily low. At the time of that recruitment, available data suggested that earlier assessments and analyses had been too optimistic, over-estimating recruitment.

A less anomalous situation could arise if T_{MAX} is lowered because new estimates of stock productivity are higher (in other words, productivity was previously under-estimated); a constant T_{TARGET} strategy could result in a target year that is now greater than T_{MAX}. Conversely, the estimate of unfished biomass could be lowered due to new estimates of compensatory effect or other limiting ecological factors. This would also result in a target year greater than T_{MAX} under a constant T_{TARGET} strategy.

Both strategies entail similar risks in cases where stock productivity is over-estimated. A constant F strategy is more conservative in that additional surplus production is not removed as the stock approaches the target biomass. However, any over-estimation of F would apply to the period from the most recent stock assessment. If the over-estimation were small, it would have a slight effect during that period and be overtaken by a slightly delayed increase in stock size. If the over-estimation was large, overfishing could occur, preventing stock growth. Pursuing a constant T_{TARGET} strategy would entail similar risks. The most important assumption in any strategy is that regular stock assessments provide a feedback loop allowing more or less continuous adjustment (at the interval of regular stock assessments) of the fishing mortality rate. Under a constant F strategy such an adjustment would only occur if recruitment had been over-estimated in the last assessment, resulting in an F that was too high. Therefore, in practice OY is likely to change under a constant F strategy as additional information allows better estimation of the current age-structure of the population. This isn't apparent in the figures because perfect information about the current state is assumed. Under a constant T_{TARGET} strategy F would be adjusted after each stock assessment so the stock rebuilds by the target year; estimation errors could also be compensated for as part of this adjustment.

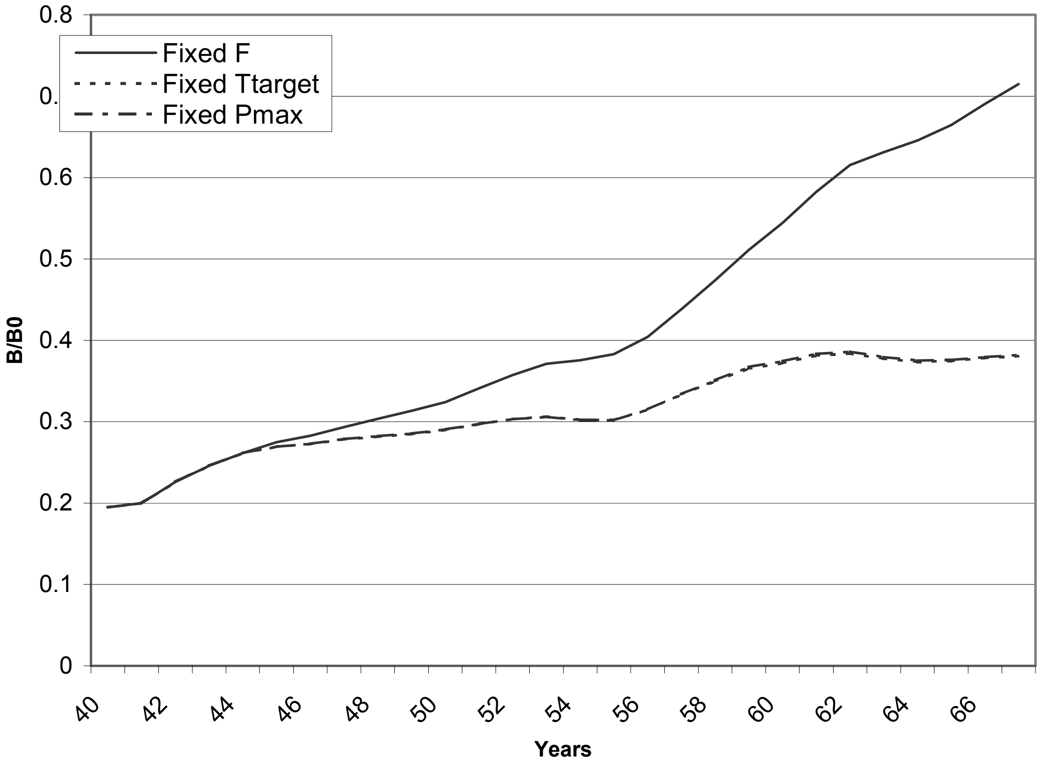

FIGURE 3-7. Biomass trajectories under different strategies.

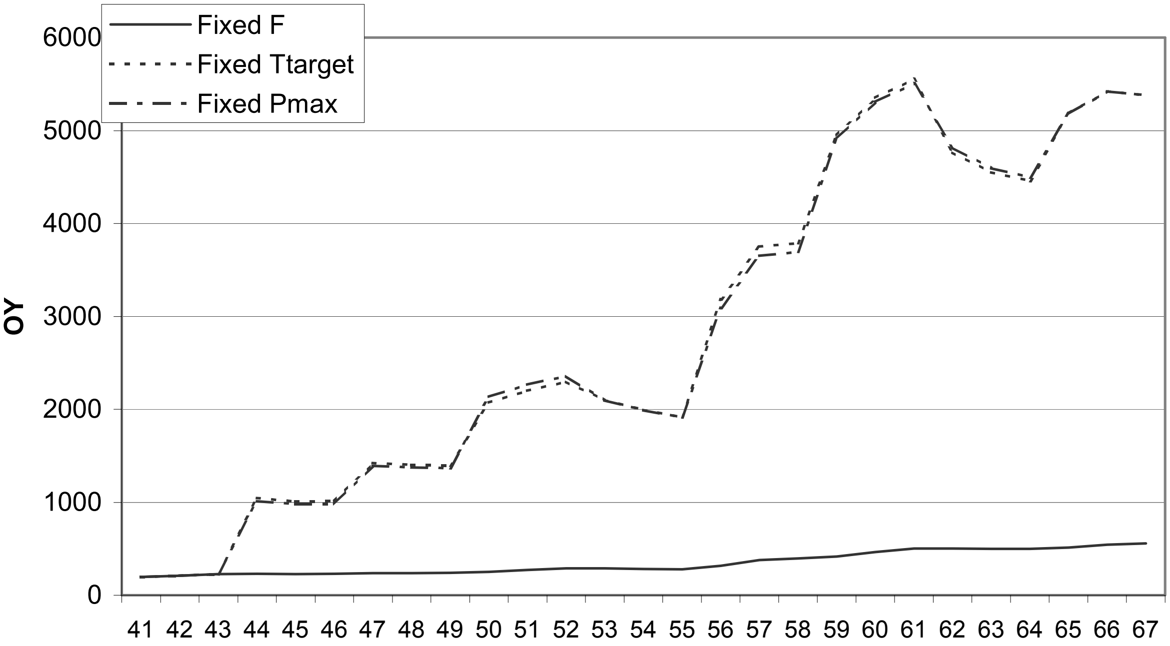

FIGURE 3-8a. Change in catch (OY) over time under different strategies.

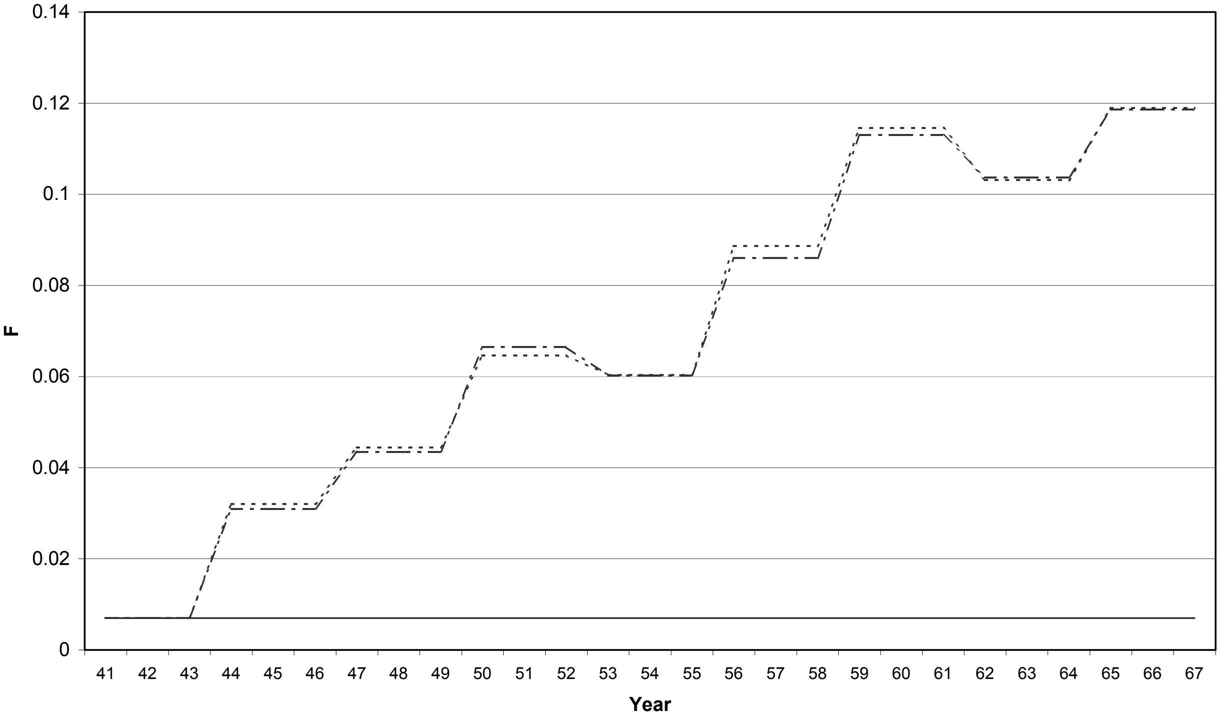

FIGURE 3-8b. Change in F rate over time under different strategies.

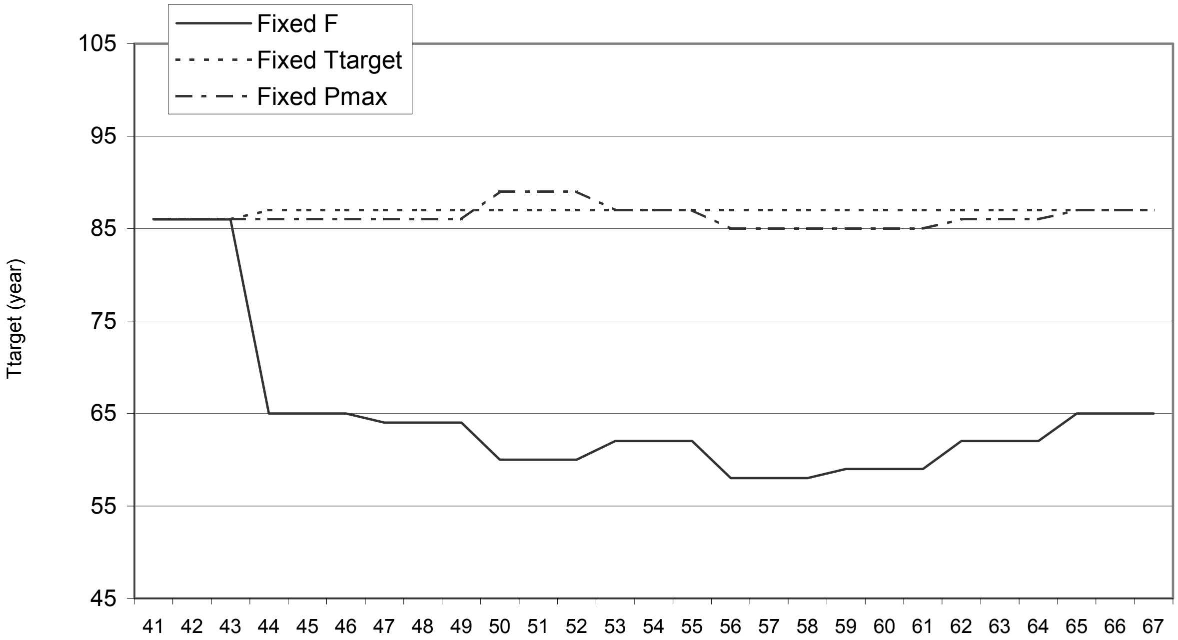

FIGURE 3-9a. Change in T_{TARGET} over time under different strategies.

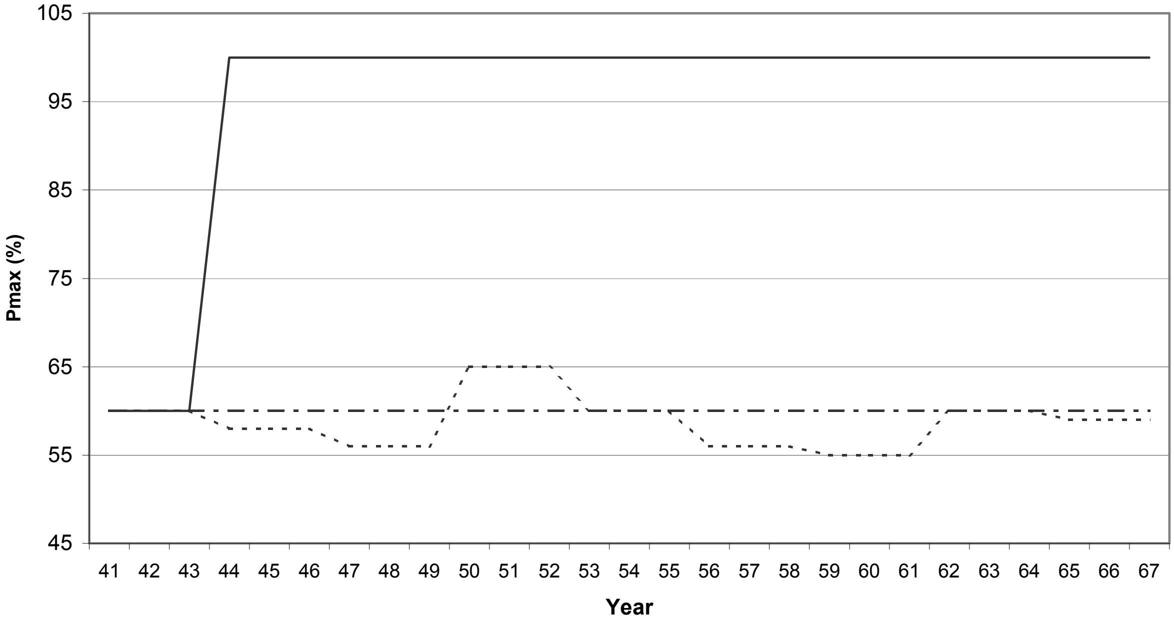

FIGURE 3-9b. Change in P_{MAX} over time under different strategies.