Appendix VIII

APPENDIX VIII

Appendix VIII-1-A

Evaluation of Alternative Outage Schedules Based on a Multi-Species Approach

EVALUATION OF ALTERNATIVE OUTAGE SCHEDULES BASED ON A MULTI-SPECIES APPROACH

Executive Summary

This report describes and illustrates a method for comparing alternative outage schedules at the Bowline Point, Indian Point, and Roseton power plants. The method uses conditional entrainment mortality rates (CMR) for five taxa of fish (striped bass, white perch, Atlantic tomcod, bay anchovy, and river herring) and outage lengths for each plant as input data and uses the metric of greatest overall reduction in CMR and Pareto-optimality calculational techniques to sort outcomes and schedules. Outcomes are unique combinations of entrainment CMR across the five taxa and schedules are the unique combinations of starting weeks for outages at the three plants that produce these outcomes. Optimal outcomes and schedules are defined in this report to be the Pareto-optimal outcomes and schedules that produce the greatest overall reduction in entrainment CMR across the taxa of interest. To illustrate this method for comparing outcomes and identifying optimal schedules, one hypothetical combination of outage lengths was used. The method described in this report does not consider other factors that may be of importance in selecting the length and timing of outages at these power plants.

Assuming outage lengths of four weeks for each unit at Bowline Point, six weeks at one unit at Indian Point, and four weeks at one unit at Roseton, about 7.3 million alternative outage schedules are possible. Of these, 12 schedules satisfy the selected optimality criteria and provide an overall reduction in CMR, compared to a baseline condition of no outages and minimum flows for efficient operation, of 16%. These 12 schedules produce only one unique combination of CMRs for the five taxa (outcome). All schedules that produce the same unique outcome are equivalent based the entrainment CMR values for each of the five taxa.

Introduction

During certain times of the year and under certain ambient water temperature conditions, reductions in cooling water flow through the cooling water systems of power plants during plant outages can reduce the annual conditional mortality rate (CMR) on entrainable size fish that may be present in the vicinity of the plant intakes. Thus, outages that occur during periods when entrainable size fish are present can reduce entrainment mortality.

The period when an outage would provide the greatest reduction in entrainment CMR is relatively simple to determine when only one taxon is of interest. However, when multiple taxa are considered, outages that reduce the entrainment CMR for one taxon may do little for another. For example, if one taxon is present near a power plant intake for 4 weeks in the winter and another is present for 4 weeks in the summer, a 4-week outage taken as a single block of time could only reduce the entrainment CMR for one taxon. Determining the period when outages from multiple power plants provide the greatest reduction in entrainment CMR for multiple taxa is more complicated still.

This report describes and illustrates a method for comparing alternative outage schedules at the Bowline Point, Indian Point, and Roseton power plants. The method uses conditional entrainment mortality rates (CMR) for five taxa of fish (striped bass, white perch, Atlantic tomcod, bay anchovy, and river herring) and outage lengths for each plant as input data and uses the metric of greatest overall reduction in CMR and Pareto-optimality calculational techniques to sort outcomes and schedules. Outcomes are unique combinations of entrainment CMR across the five taxa and schedules are the unique combinations of starting weeks for outages at the three plants that produce these outcomes. Optimal outcomes and schedules are defined in this report to be the Pareto-optimal outcomes and schedules that produce the greatest overall reduction in entrainment CMR across the taxa of interest. To illustrate this method for comparing outcomes and identifying optimal schedules, one hypothetical combination of outage lengths was used. The method described in this report does not consider other factors that may be of importance in selecting the length and timing of outages at these power plants.

Method

An overview of the method is presented in the next section and the details of the method are presented in the section after that.

Overview

The method consists of four steps:

1. Calculation of the weekly contributions to conditional mortality rates (CMR) due to entrainment. Separate values are computed for each taxon, power plant and unit using both estimated through-plant mortality rates and assumed 100% through-plant mortality rates.

2. Calculation of the CMR due to entrainment by taxon for every outage schedule under consideration. This step uses either the minimum cooling water flows for efficient power plant operation or flows that were provided in the 1981 and 1987 SPDES permits and includes the delineation of constraints that limit the outage schedules being considered.

3. Identification of the Pareto-optimal outcomes and schedules for each plant independent of the others and for all plants collectively.

4. Selection from the set of Pareto-optimal outcomes and schedules that produce the greatest overall reduction in CMR, summed over all taxa of interest, for each plant independent of the others and for all plants collectively.

Step 1. Calculate Weekly Contributions to CMR

The weekly contributions to CMR from each plant differ according to taxa. The spatial and temporal distribution of the entrainable life stages determine the pattern of weekly contributions to CMR. For example, the greatest contributions to CMR for striped bass, which generally spawns in May and June, occur in weeks 18 through 28, whereas the greatest contributions to CMR for Atlantic tomcod, which spawns in mid-December through January (Klauda et al. 1988), occur in weeks 7 through 23 (Figures 1, 2, and 3). To provide protection with outages for both taxa, some outage time should be scheduled for late winter and some for spring.

Data indicate that some eggs and larvae survive the entrainment process, as reflected in the estimated through-plant mortality rates. As directed by the New York State Department of Environmental Conservation, weekly CMR values were calculated assuming 100% of the eggs and larvae do not survive the entrainment process.

Step 2. Calculate CMR for Alternative Schedules

Alternative schedules are defined in terms of outage blocks--contiguous series of weeks during which a specified unit is scheduled to be off line. For this application, the computer algorithm for evaluating alternative schedules can make computations for zero, one or two outage blocks per unit per year for each of the three power plants. Each outage block is defined by the starting week and duration of the outage. A scenario describes the distribution of outage blocks. For example, four weeks off line at a unit might be distributed as one 4-week block, two 2-week blocks, one 1-week block and one 3-week block, or four 1-week blocks, each of which is termed an outage scenario. The computer algorithm requires that the duration of each outage block is specified in advance. Alternative schedules, defined by all possible starting weeks for each of the outage blocks, are then delineated automatically by computer.

In defining the set of alternative schedules to be evaluated, it is necessary to specify the flow regime to be used (either minimum flows for efficient operation or flows that were provided in the 1981 and 1987 SPDES permits) and the constraints to be imposed (either two units of a plant can have outages that overlap in time or they cannot, and either outages can occur at anytime during the year or be restricted to a portion of the year). The minimum flows for efficient operation and those provided in the 1981 and 1987 SPDES permits are the same for Bowline and Roseton. For Indian Point, the minimum flows for efficient operation are higher than those that were provided in the 1981 and 1987 SPDES permits.

An annual CMR value for each taxon of interest is computed for each alternative schedule. The annual CMR values are based on average estimates of weekly conditional survival rates (i.e., one minus the weekly conditional mortality rate). A product of conditional survival rates for all 52 weeks in a year is computed. The conditional mortality rate is equal to one minus the product of weekly survival rates. Thus, summing the weekly CMR values only approximates the annual CMR.

The list of CMR values for the taxa of interest is the expected outcome for the schedule. For example, with five taxa of interest, the outcome for each alternative schedule would be expressed as a list of five CMR values. Although each alternative schedule has only one expected outcome, several schedules may have the same expected outcome. Any schedules with the same outcome are equivalent with respect to the entrainment effect of the schedules on the taxa of interest.

Step 3. Identify The Set of Pareto-optimal Outcomes and Schedules

Objective criteria are used to differentiate between optimal and sub-optimal outcomes while taking into account all taxa of interest. During this step, the relative importance of the taxa and the importance of CMR to each of the taxa are not considered. Only the ordinal information (i.e., rank and not magnitude) in the CMR values for each taxon is needed.

The criteria of Pareto-optimality (Keeney and Raiffa 1976) are used to identify the initial set of optimal outcomes for each plant independent of the others and for all plants considered together. The Pareto-optimal set is found by identifying the alternative outcomes that satisfy the following condition: In comparison to an optimal outcome, any sub-optimal outcome would produce a CMR value that is worse (i.e., higher) for at least one taxon and CMR values that are no better for all other taxa. The Pareto-optimal set is the set of schedules that remains after removing all sub-optimal schedules.

Because multiple schedules may produce the same outcome and optimality is defined in terms of outcomes, the approach is to identify all unique outcomes (initially without regard to the particular schedules that produce them). Outcomes of outage schedules are considered unique if the set of CMR values for all taxa is different than that for all other outcomes (after the CMR values are expressed as percentages and rounded to integers). Next, the set of Pareto-optimal outcomes is found. All schedules that produce the Pareto-optimal outcomes are then identified. Any schedule that produces one of the outcomes in the set is considered a Pareto-optimal schedule.

Step 4. Select Schedules with the Greatest Overall Reduction in CMR

The last step of the approach is to select a subset of schedules (from the Pareto-optimal set) that provides the greatest overall protection for all taxa of interest for each plant independent of the others and for all plants considered together. The criterion is to maximize the sum (over taxa) of reductions in CMR for the taxa of interest.

Methods

Step 1

One set of power plant flow scenarios has been termed *efficient flow* (the minimum flow required for efficient operation). Efficient flow (see Attachment 1) at all of the units and plants is the baseline condition for computing the weekly contributions to CMR. Two sets of baseline CMRs are computed: one for estimated through-plant mortality and one for assumed 100% through-plant mortality. For each taxon and plant, the contribution to CMR in week *wk* (CMR^{*}_{wk}) is calculated as the weighted average of cohort-specific weekly conditional mortality rates

$$CMR^{*}_{wk} = 1 - \sum_{s=1}^{S} R_s \left[\prod_{l=1}^{L} \prod_{d \in wk} (CSR_{d\,l})^{\delta_{d\,s\,l}} \right] \qquad (1)$$

where

$CSR_{d\,l}$ = daily conditional survival rate for individuals in life stage l on day d;

s = week 1, 2, 3, ..., S of the spawning period (subscript s will also denote cohorts born in those weeks);

l = life stage 1, 2, 3, ..., L;

R_s = proportion of spawning that occurred in week s, $\sum_{s=1}^{S} R_s = 1$;

$d \in wk$ = day d within week wk; and

δ_{dsl} = the proportion of day d that individuals of cohort s spend in life-stage l ($\sum_{l} \delta_{dsl} = 1$ for all days of entrainment vulnerability for cohort s).

The weekly contributions to CMR computed in this manner are consistent with entries in the cross-credit tables from the Hudson River Settlement Agreement of 1980 (Sandler and Schoenbrod 1981). Methods for computing the daily CSR values are detailed in **Appendix** X. Weekly contributions to CMR were computed for each year from 1991 through 1997 and the average of these annual values are used as input to these analyses (see Attachment 2).

Step 2

The annual conditional mortality rate (CMR^*) for each taxon and plant is computed from the weekly contributions to CMR as

$$CMR^* = 1 - \prod_{wk=1}^{52}\left[\sum_{s=1}^{L} R_s \left[\prod_{l=1}^{L}\prod_{d \in wk}\left(CSR_{d\,l}\right)^{\delta_{dsl}}\right]\right] \quad (2)$$

which provides an approximation to the annual CMR estimates that are computed using the formulation in Appendix X

$$CMR^* = 1 - \sum_{s=1}^{L} R_s \left[\prod_{wk=1}^{52}\left[\prod_{l=1}^{L}\prod_{d \in wk}\left(CSR_{d\,l}\right)^{\delta_{dsl}}\right]\right] \quad (3)$$

For the purpose of evaluating large numbers of alternative schedules, the approximation greatly reduces computational time. The initial and time-consuming computation of intermediate terms in the formulation are done only once, rather than repeatedly for each alternative schedule. Furthermore, this approach (based on values equivalent to cross-credit table entries) is consistent with the approach used in the 1980 Hudson River Settlement Agreement. The difference between the approximation and the standard formulation is subtle. The standard formulation is based on a weighted average of products of weekly survival rates. The approximation is based on a product of weighted average weekly survival rates. In both cases, the weighting factors are the relative abundances of the weekly cohorts (the R_s terms).

Given one set of values for the weekly contribution to CMR based on the assumption of only one unit per plant operating and another set of values based on the assumption of two units operating, the annual CMR for any alternative schedule can be computed as

$$CMR^{*} = 1 - \prod_{wk=1}^{52} \left(1 - CMR^{*}_{1,wk} \right)^{\Delta_{1,wk}} \left(1 - CMR^{*}_{2,wk} \right)^{\Delta_{2,wk}} \tag{4}$$

where

$CMR^{*}_{1,wk}$	=	the weekly contribution to CMR for week *wk* given that only one unit operates during the week,
$CMR^{*}_{2,wk}$	=	the weekly contribution to CMR for week *wk* given that two units operate during the week,
$\Delta_{1,wk}$	=	1 if the schedule calls for only one unit to operate during week *wk* and 0 otherwise, and
$\Delta_{2,wk}$	=	1 if the schedule calls for two units to operate during week *wk* and 0 otherwise.

Note that if both units are not operating in a given week, wk, then $\Delta_{1,wk}=0$ and $\Delta_{2,wk}=0$. In this case, the computed weekly conditional survival rate for week, wk, based on equation (4) is equal to 1.

Step 3

In order to determine which outcomes belong to the Pareto-optimal set, comparisons are made between each unique outcome and all other unique outcomes. An outcome belongs to the Pareto-optimal set if it is no worse than any other outcome. An outcome is compared to each possible alternative and considered worse than an alternative if (1) the CMR for every taxon is at least as small as the corresponding CMR of the alternative and, (2) for at least one taxon, the CMR is less than the corresponding CMR of the alternative.

This step is implemented in several stages. First, the Pareto-optimal outcomes for each plant are identified. Next, all possible combinations of the three plant-specific Pareto-optimal outcomes are formed. Finally, the Pareto-optimal set for the combined outcomes is identified. This stage-wise method reduces computational time. A proof that the Pareto-optimal set for all combined outcomes consists of the plant-specific Pareto-optimal outcomes as found here is presented in Attachment 3 to this Appendix.

The CMR value for each taxon *k* for the three plants combined is computed as

$$CMR^{**}_{k,m} = 1 - \prod_{p=1}^{3} \left(1 - CMR^{*}_{k,p,m} \right) \tag{5}$$

where

$CMR^{*}_{k,p,m}$ = the annual conditional mortality rate for taxon k plant p under alternative schedule m.

The method used to identify the plant-specific Pareto-optimal outcomes based on the $CMR^{*}_{k,p,m}$ values is also used to identify the overall Pareto-optimal outcomes based on the $CMR^{**}_{k,m}$ values.

Step 4

The reduction in CMR is calculated for each taxon of interest and each of the outcomes in the final Pareto-optimal set. The reduction in CMR for each taxon is calculated from the baseline condition of the CMR with two-unit operation with efficient flow at each of the three plants in every week of the year (schedule m_0):

$$CMR^{**}_{k,m_0} = 1 - \prod_{p=1}^{3} \left(1 - CMR^{*}_{k,p,m_0} \right) \tag{6}$$

where

$$CMR^{*}_{k,p,m_0} = 1 - \prod_{wk=1}^{52} \left(1 - CMR^{*}_{k,p,2,wk} \right) \tag{7}$$

and

$CMR^{*}_{k,p,2,wk}$ = the weekly contribution to CMR for taxon k in week wk at plant p with two-unit operation.

The reduction in CMR for taxon k under schedule m is calculated as

$$\beta_{k,m} = CMR^{**}_{k,m_0} - CMR^{**}_{k,m} \tag{8}$$

The reduction in CMR is computed for every schedule in the overall Pareto-optimal set. For each such schedule, the total reduction over the taxa of interest is computed as

$$\beta_{sum,m} = \sum_{i=1}^{n} \beta_{i,m} \tag{9}$$

where n is the number of taxa of interest. The final selection of schedules is made by identifying the schedules with the greatest overall reduction in CMR; that is, the schedules with the largest value of $\beta_{sum,m}$.

Illustrative Examples

Seven scenarios were selected to illustrate the method. They correspond with alternatives identified in DEIS section VIII. Scenarios 1 through 4 are based on estimated through-plant mortality rates and Scenarios 5 through 7 are based on assumed 100% through-plant mortality rates (Figure 4). All of the scenarios are based on the constraint that the two units of Bowline cannot have overlapping outages.

Estimated through-plant mortality rate scenarios

The maximum CMR values for the three plants based on estimated through-plant mortality rates, no outages, and minimum flows for efficient operation are listed in Tables 1, 2, and 3.

Scenario 1

The outage blocks to be evaluated for Scenario 1 are

Bowline Point -- one 4-week outage per year at unit A, and one 4-week outage per year at unit B;

Indian Point -- one 6-week outage per year at either unit A or B; and

Roseton -- one 4-week outage per year at either unit A or B.

The outages are not constrained to occur during the windows that were provided in the 1981 and 1987 SPDES permits. The outage duration for Indian Point is the same as that provided in the 1981 and 1987 SPDES permits. The outage durations for Bowline and Roseton are about the same as those that were provided in the 1981 and 1987 SPDES permits [Bowline (30 days and 31 days) and Roseton (30 days)] because the method was designed to consider outages in weekly increments.

The next step of the method is to identify the plant-specific, Pareto-optimal outcomes and schedules given the conditions of the example and the scenario of outage blocks. This is done by first elaborating all possible schedules at each plant and then eliminating schedules that do not satisfy the constraints of the scenario. All unique outcomes from the remaining schedules are then identified. Finally, the Pareto-optimal outcomes and the schedules that produce them are identified.

For Bowline Point, the total number of possible schedules is 52 x 52 = 2,704, and the number of schedules after considering the constraint of no simultaneous two-unit outages is 2,340. From these, 10 unique outcomes defined by the CMR values for the five taxa would result (Table 2). Of these unique outcomes, 3 are Pareto-optimal (Table 3). The 3 Pareto-optimal outcomes are produced by 37 schedules (Figure 5). The number of schedules that produce the unique outcomes numbered 1 through 3 (the *outcome indices*) are 5, 30, and 2, respectively. These 37 schedules are the Pareto-optimal schedules.

For Indian Point, the total number of possible schedules is 52, and the number of schedules after considering the constraint of no simultaneous two-unit outages is still 52 because for this scenario, only one unit is out in each year. From these 52 schedules, 20 unique outcomes would result (Table 4). Of the 20 unique outcomes, 5 are Pareto-optimal (Table 5). The Pareto-optimal outcomes can be produced by 5 different schedules (Figure 6): a different schedule for each outcome.

For Roseton, the total number of schedules is also 52. These schedules produce 4 unique outcomes (Table 6), of which 1 is Pareto-optimal (Table 7). The Pareto-optimal outcome results from 6 different schedules (Figure 7).

The next step of the method is to combine the Pareto-optimal outcomes from the three plants and to identify the Pareto-optimal combined outcomes. The CMR values for the combined outcomes are larger than the plant-specific CMR values because of the combined effects of all three plants. The 15 possible combined outcomes are the product of 3 Pareto-optimal outcomes from Bowline Point, 5 from Indian Point, and 1 from Roseton. Of these combined outcomes, 11 are Pareto-optimal (Table 8) and result from 726 schedules.

The final step of the method is to identify the outcomes and schedules from the Pareto-optimal set that produce the greatest overall reduction of CMR for the five taxa. For this example, only 1 of the 11 Pareto-optimal combined outcomes has the greatest overall reduction in CMR (Tables 9 and 10). The greatest overall reduction in CMR is 16%. A total of 12 schedules are associated with the selected outcome (Table 11, and Figure 8).

Scenario 2

Scenario 2 is the same as Scenario 1 except it uses the flows that were provided in the 1981 and 1987 SPDES permits rather than the minimum required for efficient operation of Indian Point. The resulting CMR values are summarized in Table 13, and the corresponding reductions in CMR (from the baseline summarized in Table 1) are summarized in Table 12.

Scenario 3

Scenario 3 is the same as Scenario 2 except that the outcomes are based on schedules at each plant selected independently of the schedules at the other plants. The general method can also be modified to assess the effects of selecting Pareto-optimal schedules at each plant independently of the others. For this type of assessment, the last stage of *Step 3* of the method is dropped. Only the *plant-specific* Pareto-optimal outcomes and schedules are identified. The schedules with the greatest overall reduction in CMR for each plant then are identified. All possible combinations of these schedules are formed, the CMR associated with each combined schedule is computed, and the CMRs are averaged. Results from this modification to Scenario 2 are summarized in Tables 14 and 15. For this example, 37 schedules at Bowline Point, 2 schedules at Indian Point, and 6 schedules at Roseton were selected, for a total of 444 (37 x 2 x 6) combined schedules.

Scenario 4

Scenario 4 provides a point of reference. It is similar to Scenario 3 in that it is based on flows that were provided in the 1981 and 1987 SPDES permits and outages at each plant scheduled independently. Scenario 4 differs from Scenario 3 in that the outages are constrained to the periods that were provided in the 1981 and 1987 SPDES permits, i.e.,

Bowline Point -- one 4-week outage (30 unit-days) per year between May 15 (week 19) and June 30 (week 26),
one 4-week outage (31 unit-days) in the month of July (weeks 27 through 30), and
Settlement Agreement Flows;

Indian Point -- one 6-week (42 unit-days) outage per year between May 10 (week 19) and August 10 (week 32), and
Settlement Agreement Flows;

Roseton -- one 4-week (30 unit-days) outage per year between May 15 (week 19) and June 30 (week 26), and
Settlement Agreement Flows;

and the reduction in CMR was not calculated using Pareto-optimality techniques. Rather, the reduction in CMR was calculated as the average of all possible outage schedules that could occur partly or totally within the outage periods that were provided in the 1981 and 1987 SPDES permits. Under Scenario 4, Bowline Point has 3 possible schedules, Indian Point has 6 possible schedules and Roseton has 3 possible schedules, for a total of 54 (3 x 6 x 3) possible schedules. The average CMRs from these 54 schedules are summarized in Tables 16 and 17.

Assumed 100% through-plant mortality scenarios

The maximum CMRs, assuming 100% through-plant mortality rates are summarized in Table 18.

Scenarios 5, 6 and 7

Scenarios 5, 6, and 7 are identical to Scenarios 2, 3, and 4 except that they are based on assumed 100% through-plant mortality rates. Results from the assessment of Scenario 5 are summarized in Tables 19 and 20. Results from the assessment of Scenario 6 are summarized in Tables 21 and 22. Results form the assessment of Scenario 7 are summarized in Tables 23 and 24.

Summary

This method provides a means to objectively compare and define optimal schedules of power plant outages. Optimality is based on the conditional entrainment mortality rate for selected taxa of fish. The method has the advantage of identifying a relatively small number of optimal schedules even when the initial number of alternatives is very large. In an illustrative example (Scenario 1), the initial number of possible alternative outage schedules is 52^4 or about 7.3 million. This number was reduced to 12 optimal schedules.

The optimal schedules are identified in stages. The key stages (and the number of schedules at each stage from Scenario 1 of the illustrative example) are:

- Calculation of plant-specific CMR values for all alternative schedules (Bowline Point -- 2,704 schedules, Indian Point -- 52 schedules, Roseton -- 52 schedules)

- Identification of Pareto-optimal outcomes and associated schedules for each plant; outcomes are defined by the CMR values for the taxa of interest (Bowline Point -- 37 schedules, Indian Point -- 5 schedules, Roseton -- 6 schedules)

- Delineation of combined outcomes and associated schedules across plants (1110 combined schedules, 37 x 5 x 6)

- Identification of Pareto-optimal combined outcomes and associated schedules

(726 combined schedules)

- Identification of Pareto-optimal combined outcomes and associated schedules that provide the greatest overall reduction in CMR (12 combined schedules).

For the illustrative example (Scenario 1), the greatest overall reduction is 16%. All of the 12 optimal schedules provide a reduction in CMR of 16%.

Although all schedules identified in the last stage produce the same overall reduction in CMR, they do not necessarily all produce the same CMR values for each of the taxa. Therefore, schedules from the final optimal set may produce different minimum or maximum (over the taxa of interest) reductions in CMR. However, all schedules that produce the same unique *outcome* are equivalent in terms of entrainment CMR for each of the taxa of interest.

References

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Table 1. Maximum annual conditional entrainment mortality rates (percent) for the Bowline, Indian Point and Roseton power plants based on estimated through-plant mortality rates, efficient flow, and no outages.

	Absolute Reduction in Entrainment CMR					
Plant	Atlantic Tomcod	Bay Anchovy	River Herring	Striped Bass	White Perch	All taxa combined
BP	8	5	0	1	0	14
IP	16	15	1	12	5	49
RS	2	1	4	4	7	18
All Plants	24	20	5	16	12	77

Table 2. Conditional entrainment mortality rates (percent) for all unique outcomes for Bowline Point Generating Station based on estimated through-plant mortality rates, efficient flow, outages scheduled jointly among the plants and no window during which outages must be taken (Scenario 1 described in the text).

Atlantic tomcod CMR	Bay Anchovy CMR	River Herring CMR	Striped Bass CMR	White Perch CMR
8	5	0	1	0
7	5	0	1	0
6	5	0	1	0
8	4	0	1	0
7	4	0	1	0
5	5	0	1	0
6	4	0	1	0
8	3	0	1	0
8	4	0	0	0
8	3	0	0	0

Table 3. Conditional entrainment mortality rates (percent) for all unique, Pareto-optimal outcomes for Bowline Point Generating Station based on estimated through-plant mortality rates, efficient flow, outages scheduled jointly among the plants and no window during which outages must be taken (Scenario 1 described in the text).

Outcome Number	Atlantic tomcod CMR	Bay Anchovy CMR	River Herring CMR	Striped Bass CMR	White Perch CMR
1	5	5	0	1	0
2	6	4	0	1	0
3	8	3	0	0	0

Table 4. Conditional entrainment mortality rates (percent) for all unique outcomes for Indian Point Generating Station based on estimated through-plant mortality rates, efficient flow, outages scheduled jointly among the plants and no window during which outages must be taken (Scenario 1 described in the text).

Atlantic tomcod CMR	Bay Anchovy CMR	River Herring CMR	Striped Bass CMR	White Perch CMR
16	15	1	12	5
15	15	1	12	5
13	15	1	12	5
12	15	1	12	5
11	15	1	12	5
14	15	1	12	5
14	15	1	11	4
14	14	1	10	4
14	14	1	9	4
15	13	1	7	3
15	12	1	7	3
16	11	1	7	3
16	10	1	8	4
16	10	1	9	4
16	10	1	10	4
16	10	1	12	5
16	11	1	12	5
16	12	1	12	5
16	13	1	12	5
16	14	1	12	5

Table 5. Conditional entrainment mortality rates (percent) for all unique, Pareto-optimal outcomes for Indian Point Generating Station based on estimated through-plant mortality rates, efficient flow, outages scheduled jointly among the plants and no window during which outages must be taken (Scenario 1 described in the text).

Outcome Number	Atlantic tomcod CMR	Bay Anchovy CMR	River Herring CMR	Striped Bass CMR	White Perch CMR
1	11	15	1	12	5
2	14	14	1	9	4
3	15	12	1	7	3
4	16	11	1	7	3
5	16	10	1	8	4

Table 6. Conditional entrainment mortality rates (percent) for all unique outcomes for Roseton Generating Station and Scenario 1 based on estimated through-plant mortality rates, efficient flow, outages scheduled jointly among the plants and no window during which outages must be taken (Scenario 1 described in the text).

Atlantic tomcod CMR	Bay Anchovy CMR	River Herring CMR	Striped Bass CMR	White Perch CMR
2	1	4	4	7
2	1	3	4	7
2	1	3	3	6
2	1	3	3	7

Table 7. Conditional entrainment mortality rates (percent) for all unique, Pareto-optimal outcomes for Roseton Generating Station based on estimated through-plant mortality rates, efficient flow, outages scheduled jointly among the plants and no window during which outages must be taken (Scenario 1 described in the text)..

Outcome Number	Atlantic tomcod CMR	Bay Anchovy CMR	River Herring CMR	Striped Bass CMR	White Perch CMR
1	2	1	3	3	6

Table 8. Pareto-optimal outcomes for the Bowline, Indian Point and Roseton power plants combined based on estimated through-plant mortality rates, efficient flow, outages scheduled jointly among the plants and no window during which outages must be taken (Scenario 1 described in the text).

Bowline Point Outcome Number	Indian Point Outcome Number	Roseton Outcome Number
1	1	1
1	2	1
1	3	1
1	4	1
1	5	1
2	1	1
2	3	1
2	5	1
3	1	1
3	3	1
3	5	1

Table 9. Reductions in CMR for the Pareto-optimal outcome with the greatest overall reduction in CMR for the Bowline, Indian Point and Roseton power plants combined based on estimated through-plant mortality rates, efficient flow, outages scheduled jointly among the plants and no window during which outages must be taken (Scenario 1 described in the text).

	Absolute Reduction in Entrainment CMR					
Plant	Atlantic Tomcod	Bay Anchovy	River Herring	Striped Bass	White Perch	All taxa combined
BP	0	2	0	1	0	3
IP	1	3	0	5	2	11
RS	0	0	1	1	1	3
All Plants	1	5	1	6	3	16

Table 10. Conditional entrainment mortality rates for the Pareto-optimal outcome with the greatest overall reduction in CMR for the Bowline, Indian Point and Roseton power plants combined based on estimated through-plant mortality rates, efficient flow, outages scheduled jointly among the plants and no window during which outages must be taken (Scenario 1 described in the text).

	Absolute Reduction in Entrainment CMR					
Plant	Atlantic Tomcod	Bay Anchovy	River Herring	Striped Bass	White Perch	All taxa combined
BP	8	3	0	0	0	11
IP	15	12	1	7	3	38
RS	2	1	3	3	6	15
All Plants	23	15	4	10	9	61

Table 11. Number of outage schedules for the Pareto-optimal outcomes with the greatest overall reductions in CMR for the Bowline, Indian Point, and Roseton power plants combined based on estimated through-plant mortality rates, efficient flow, outages scheduled jointly among the plants and no window during which outages must be taken (Scenario 1 described in the text).

Outcome Index			Number of Schedules			
Bowline Point	Indian Point	Roseton	Bowline Point	Indian Point	Roseton	Total
3	3	1	2	1	6	12

Table 12. Reductions in CMR for the Pareto-optimal outcome with the greatest overall reduction in CMR for the Bowline, Indian Point and Roseton power plants combined based on estimated through-plant mortality rates, permitted flow, outages scheduled jointly among the plants and no window during which outages must be taken (Scenario 2 described in the text).

	Absolute Reduction in Entrainment CMR					
Plant	Atlantic Tomcod	Bay Anchovy	River Herring	Striped Bass	White Perch	All taxa combined
BP	0	2	0	1	0	3
IP	2	3	0	6	2	13
RS	0	0	1	1	1	3
All Plants	2	5	1	7	3	18

Table 13. Conditional entrainment mortality rates for the Pareto-optimal outcome with the greatest overall reduction in CMR for the Bowline, Indian Point and Roseton power plants combined based on estimated through-plant mortality rates, permitted flow, outages scheduled jointly among the plants and no window during which outages must be taken (Scenario 2 described in the text).

	Absolute Reduction in Entrainment CMR					
Plant	Atlantic Tomcod	Bay Anchovy	River Herring	Striped Bass	White Perch	All taxa combined
BP	8	3	0	0	0	11
IP	14	12	1	6	3	36
RS	2	1	3	3	6	15

All Plants	22	15	4	9	9	59

Table 14. Reductions in CMR for the Pareto-optimal outcome with the greatest overall reduction in CMR for the Bowline, Indian Point and Roseton power plants combined based on estimated through-plant mortality rates, permitted flow, outages scheduled independently among the plants and no window during which outages must be taken (Scenario 3 described in the text).

	Absolute Reduction in Entrainment CMR					
Plant	Atlantic Tomcod	Bay Anchovy	River Herring	Striped Bass	White Perch	All taxa combined
BP	2	1	0	0	0	3
IP	2	4	0	6	2	14
RS	0	0	1	1	1	3
All Plants	3	4	1	6	3	17

Table 15. Conditional entrainment mortality rates for the Pareto-optimal outcome with the greatest overall reduction in CMR for the Bowline, Indian Point and Roseton power plants combined based on estimated through-plant mortality rates, permitted flow, outages scheduled independently among the plants and no window during which outages must be taken (Scenario 3 described in the text).

	Absolute Reduction in Entrainment CMR					
Plant	Atlantic Tomcod	Bay Anchovy	River Herring	Striped Bass	White Perch	All taxa combined
BP	6	4	0	1	0	11
IP	14	11	1	6	3	35
RS	2	1	3	3	6	15
All Plants	21	16	4	10	9	60

Table 16. Reductions in CMR for the Pareto-optimal outcome with the greatest overall reduction in CMR for the Bowline, Indian Point and Roseton power plants combined based on estimated through-plant mortality rates, permitted flow, outages scheduled independently among the plants and permitted windows during which outages must be taken (Scenario 4 described in the text).

	Absolute Reduction in Entrainment CMR					
Plant	Atlantic Tomcod	Bay Anchovy	River Herring	Striped Bass	White Perch	All taxa combined
BP	0	2	0	0	0	2
IP	2	4	0	4	2	12
RS	0	0	1	1	1	3
All Plants	2	5	1	4	3	15

Table 17. Conditional entrainment mortality rates for the Pareto-optimal outcome with the greatest overall reduction in CMR for the Bowline, Indian Point and Roseton power plants combined based on estimated through-plant mortality rates, permitted flow, outages scheduled independently among the plants and permitted windows during which outages must be taken (Scenario 4 described in the text).

	Absolute Reduction in Entrainment CMR					
Plant	Atlantic Tomcod	Bay Anchovy	River Herring	Striped Bass	White Perch	All taxa combined
BP	8	3	0	1	0	12
IP	14	11	1	8	3	37
RS	2	1	3	3	6	15
All Plants	22	15	4	12	9	62

Table 18. Maximum annual conditional entrainment mortality rates (percent) for the Bowline, Indian Point and Roseton power plants based on estimated through-plant mortality rates, efficient flow, and no outages.

	Absolute Reduction in Entrainment CMR					
Plant	Atlantic Tomcod	Bay Anchovy	River Herring	Striped Bass	White Perch	All taxa combined
BP	14	5	0	3	1	23
IP	25	15	1	36	9	86
RS	3	1	4	11	11	30
All Plants	37	20	5	45	20	127

Table 19. Reductions in CMR for the Pareto-optimal outcome with the greatest overall reduction in CMR for the Bowline, Indian Point and Roseton power plants combined based on 100% through-plant mortality rates, permitted flow, outages scheduled jointly among the plants and no window during which outages must be taken (Scenario 5 described in the text).

	Absolute Reduction in Entrainment CMR					
Plant	Atlantic Tomcod	Bay Anchovy	River Herring	Striped Bass	White Perch	All taxa combined
BP	3	1	0	1	1	6
IP	3	3	0	16	4	26
RS	0	0	0	1	1	2
All Plants	4	4	0	16	5	29

Table 20. Conditional entrainment mortality rates for the Pareto-optimal outcome with the greatest overall reduction in CMR for the Bowline, Indian Point and Roseton power plants combined based on 100% through-plant mortality rates, permitted flow, outages scheduled jointly among the plants and no window during which outages must be taken (Scenario 5 described in the text).

	Absolute Reduction in Entrainment CMR					
Plant	Atlantic Tomcod	Bay Anchovy	River Herring	Striped Bass	White Perch	All taxa combined
BP	11	4	0	2	0	17
IP	22	12	1	20	5	60
RS	3	1	4	10	10	28
All Plants	33	16	5	29	15	98

Table 21. Reductions in CMR for the Pareto-optimal outcome with the greatest overall reduction in CMR for the Bowline, Indian Point and Roseton power plants combined based on 100% through-plant mortality rates, permitted flow, outages scheduled independently among the plants and no window during which outages must be taken (Scenario 6 described in the text).

	Absolute Reduction in Entrainment CMR					
Plant	Atlantic Tomcod	Bay Anchovy	River Herring	Striped Bass	White Perch	All taxa combined
BP	3	1	0	1	1	6
IP	3	3	0	16	4	26
RS	0	0	0	1	1	2
All Plants	4	4	0	16	5	29

Table 22. Conditional entrainment mortality rates for the Pareto-optimal outcome with the greatest overall reduction in CMR for the Bowline, Indian Point and Roseton power plants combined based on 100% through-plant mortality rates, permitted flow, outages scheduled independently among the plants and no window during which outages must be taken (Scenario 6 described in the text)..

	Absolute Reduction in Entrainment CMR					
Plant	Atlantic Tomcod	Bay Anchovy	River Herring	Striped Bass	White Perch	All taxa combined
BP	11	4	0	2	0	17
IP	22	12	1	20	5	60
RS	3	1	4	10	10	28
All Plants	33	16	5	29	15	98

Table 23. Reductions in CMR for the Pareto-optimal outcome with the greatest overall reduction in CMR for the Bowline, Indian Point and Roseton power plants combined based on 100% through-plant mortality rates, permitted flow, outages scheduled independently among the plants and permitted windows during which outages must be taken (Scenario 4 described in the text).

	Absolute Reduction in Entrainment CMR					
Plant	Atlantic Tomcod	Bay Anchovy	River Herring	Striped Bass	White Perch	All taxa combined
BP	0	2	0	1	1	4
IP	3	4	0	11	3	21
RS	0	0	0	1	1	2
All Plants	2	5	0	11	5	23

Table 24. Conditional entrainment mortality rates for the Pareto-optimal outcome with the greatest overall reduction in CMR for the Bowline, Indian Point and Roseton power plants combined based on 100% through-plant mortality rates, permitted flow, outages scheduled independently among the plants and permitted windows during which outages must be taken (Scenario 4 described in the text).

	Absolute Reduction in Entrainment CMR					
Plant	Atlantic Tomcod	Bay Anchovy	River Herring	Striped Bass	White Perch	All taxa combined
BP	14	3	0	2	0	19
IP	22	11	1	25	6	65
RS	3	1	4	10	10	28
All Plants	35	15	5	34	15	104

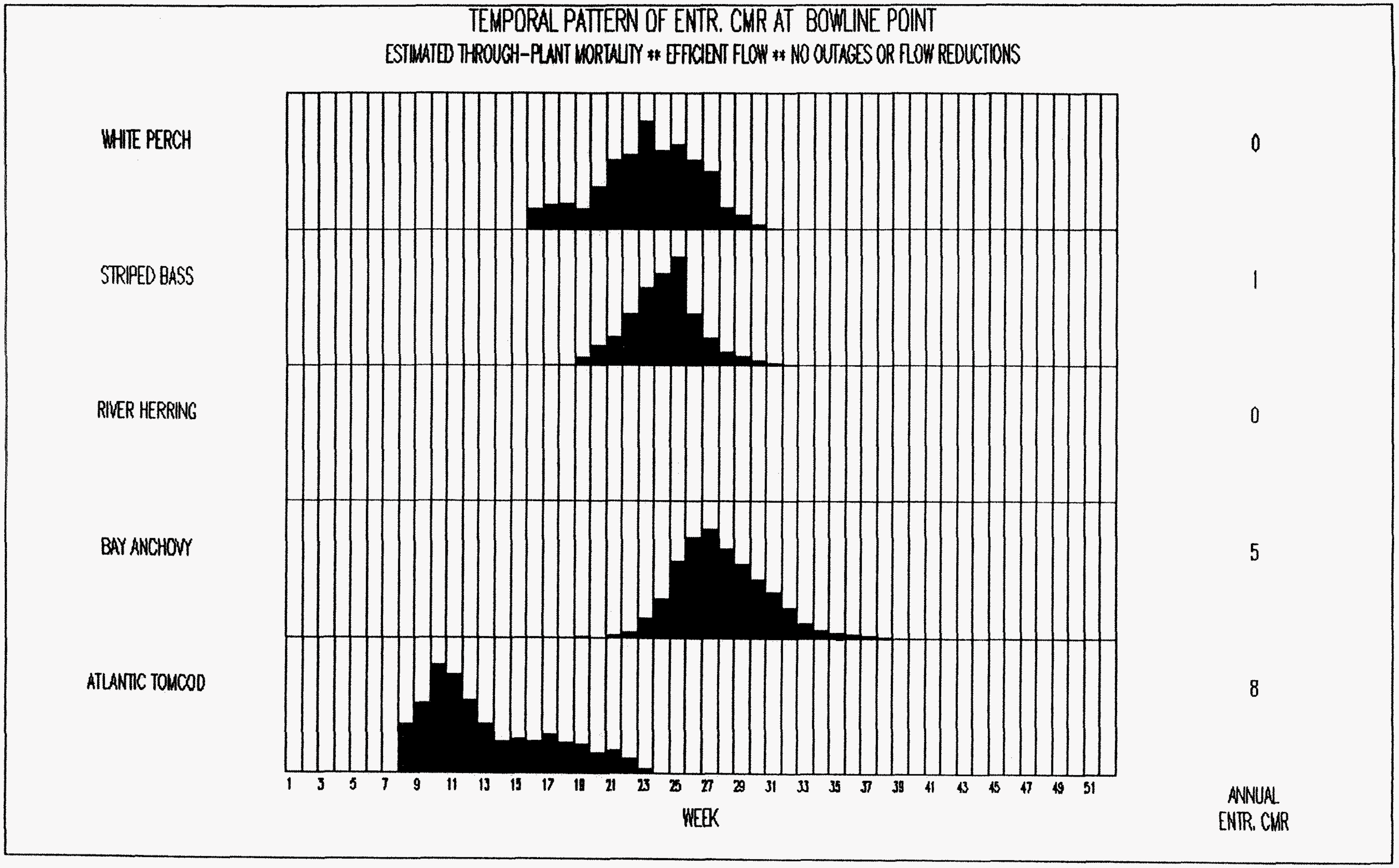

Figure 1. Weekly contribution to the annual conditional entrainment mortality rates (CMR) for five fish taxa entrained at Bowline Point Generating Station on the Hudson River, New York (1991-1997 average) and the maximum CMR based on efficient flow, estimated through-plant mortality, and no outages.

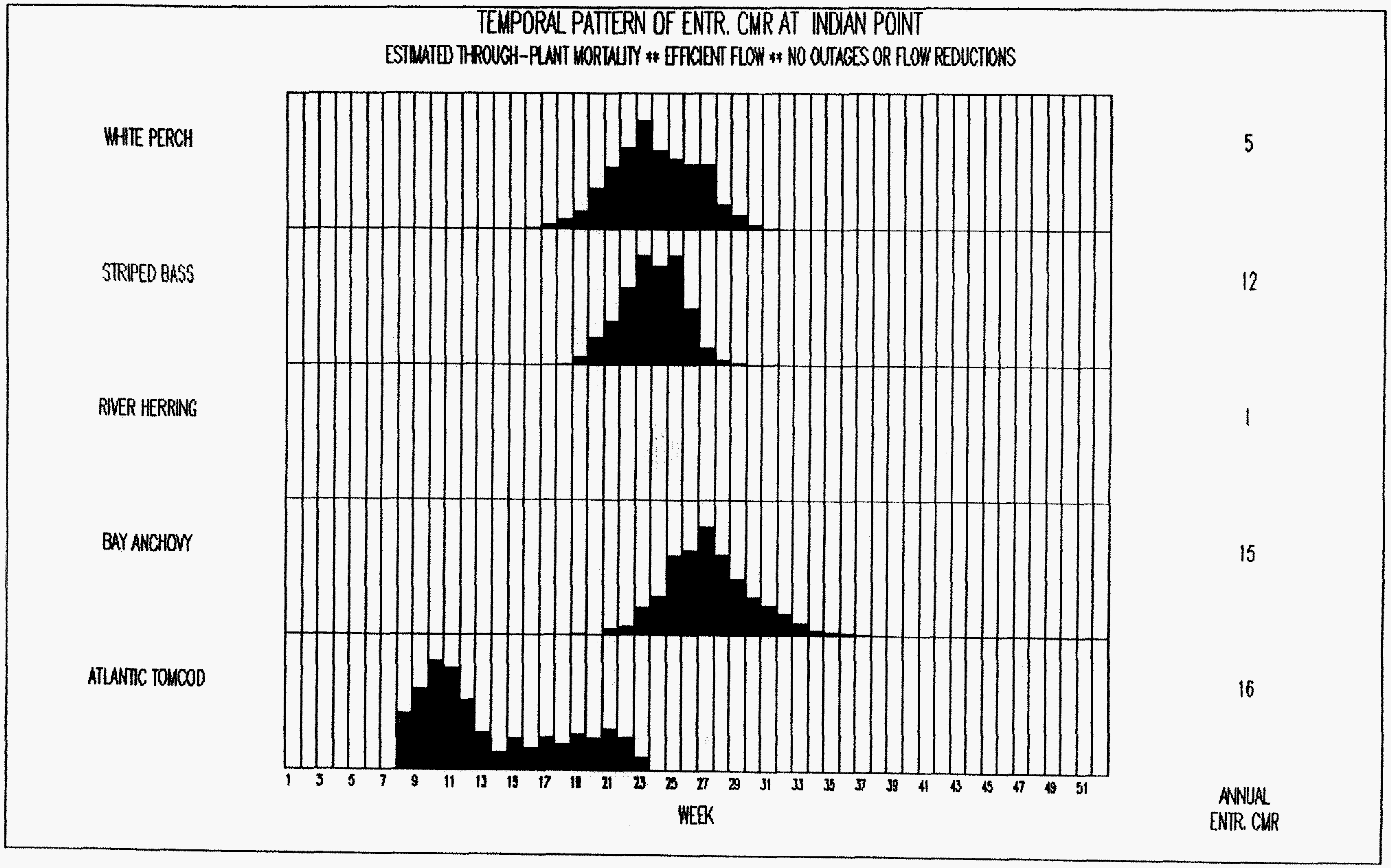

Figure 2. Weekly contribution to the annual conditional entrainment mortality rates (CMR) for five fish taxa entrained at Indian Point Generating Station on the Hudson River, New York (1991-1997 average) based on efficient flow, estimated through-plant mortality for ichthyoplankton, and no outages or flow reductions.

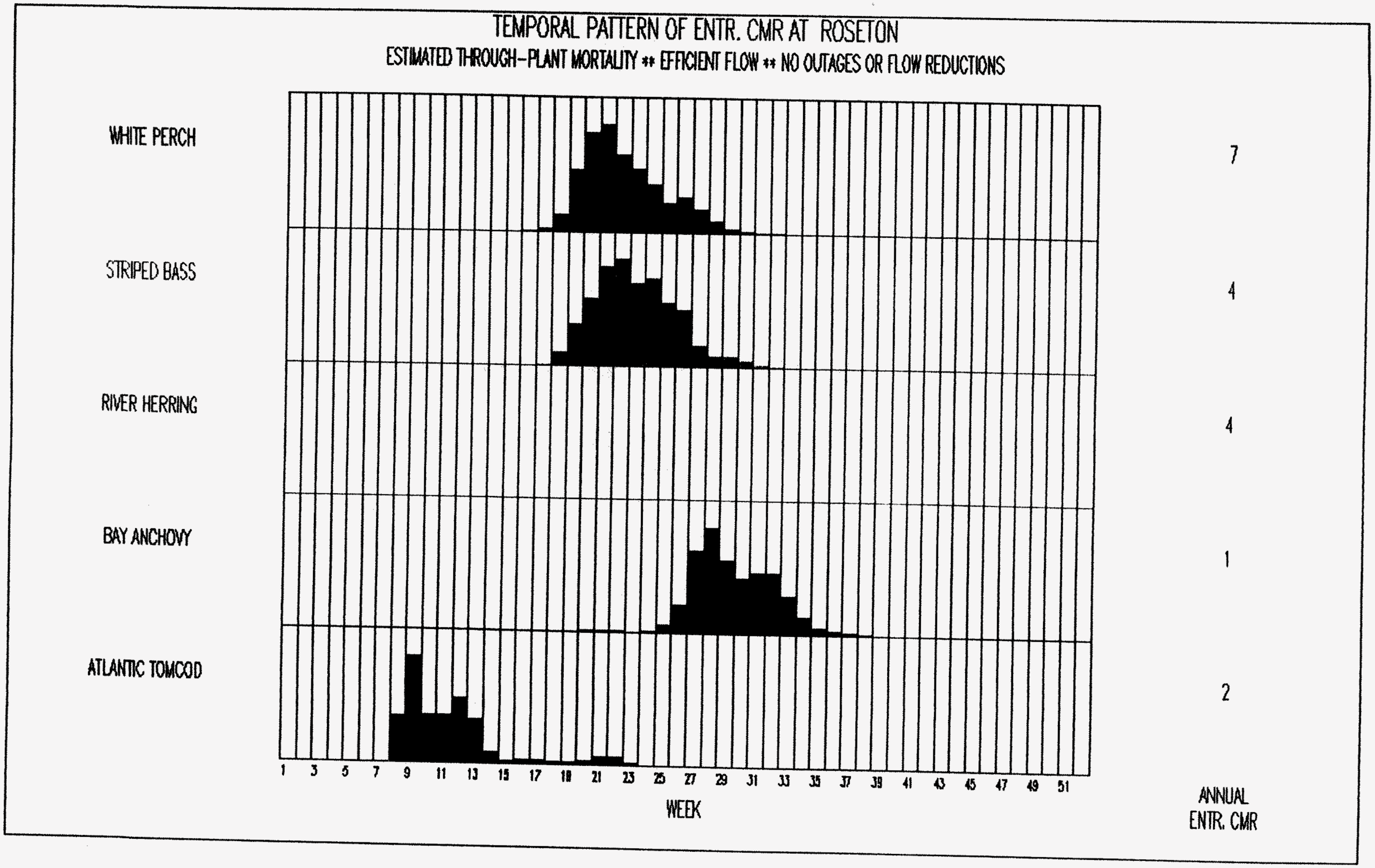

Figure 3. Weekly contribution to the annual conditional entrainment mortality rates (CMR) for five fish taxa entrained at Roseton Generating Station on the Hudson River, New York (1991-1997 average) based on efficient flow, estimated through-plant mortality for ichthyoplankton, and no outages or flow reductions.

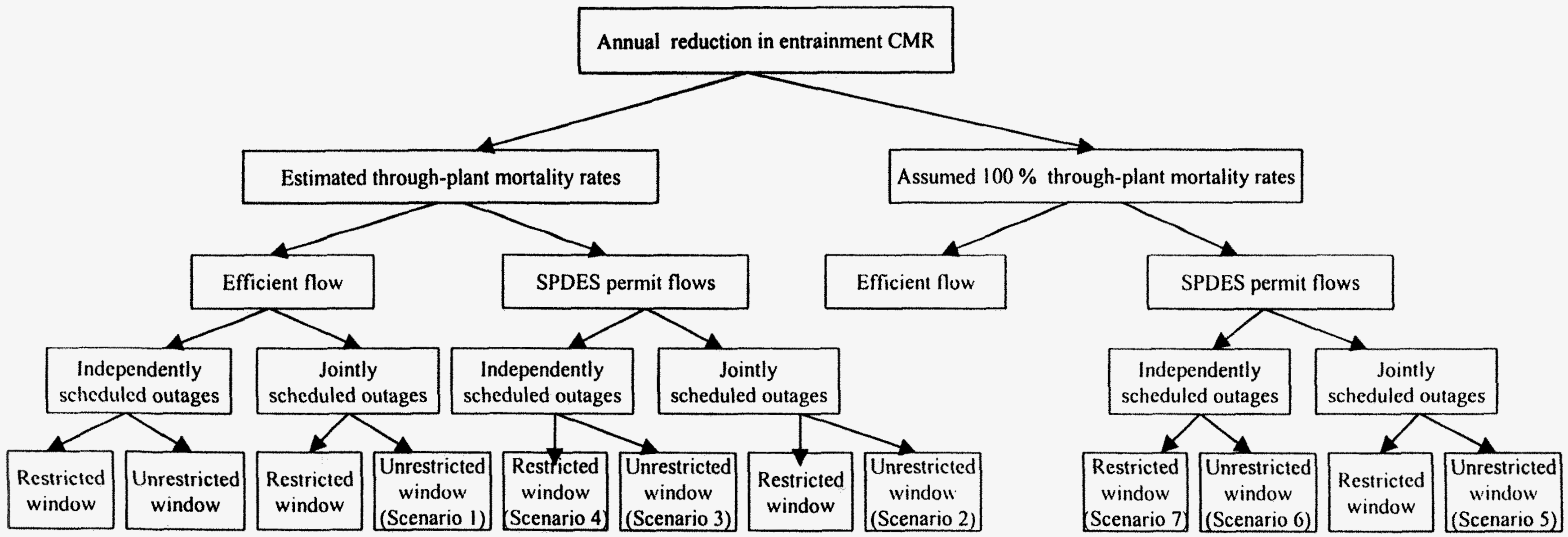

Figure 4. Derivation of Scenarios. Scenarios 4 and 7 represent average values rather than Pareto-optimal solutions.

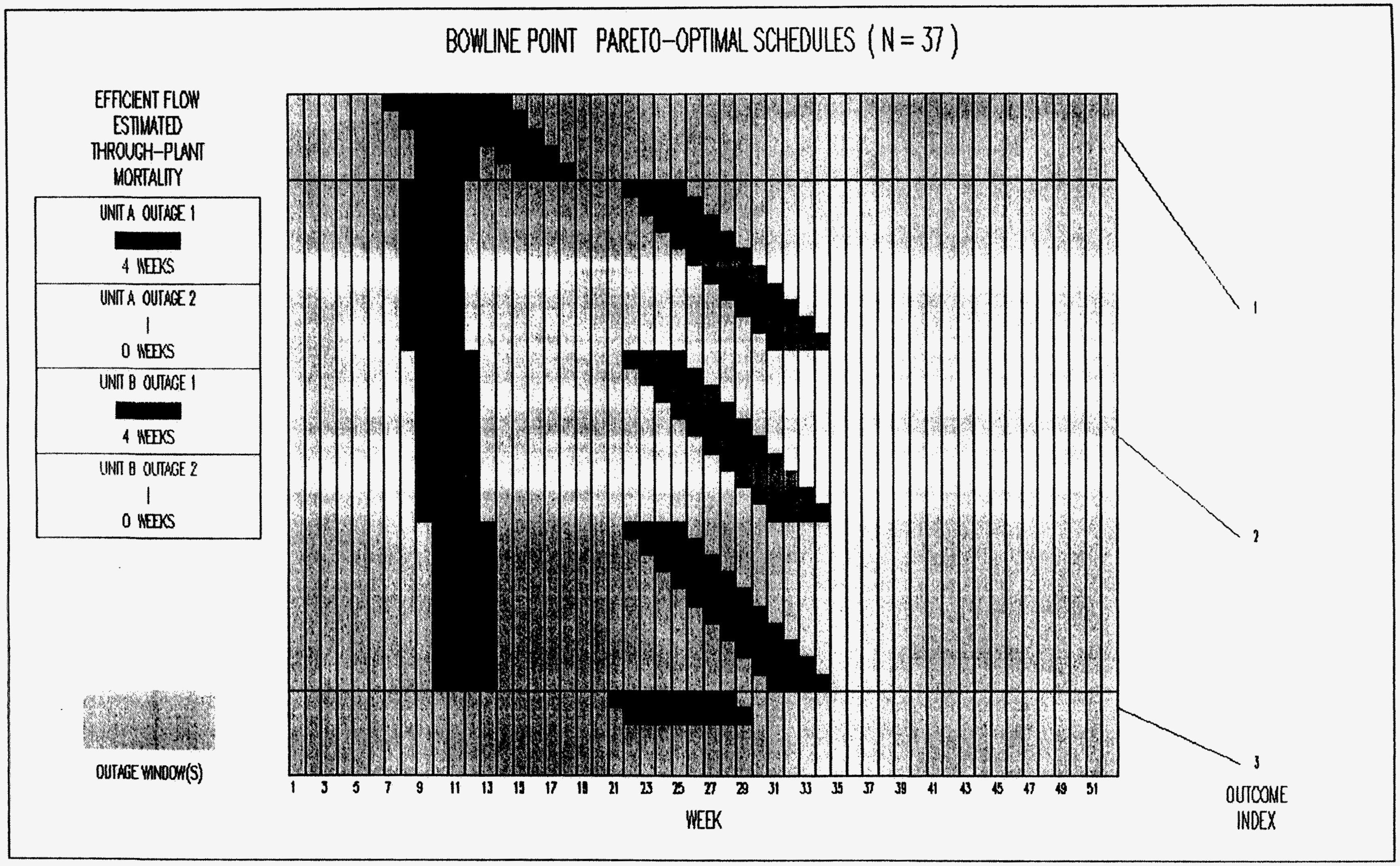

Figure 5. Set of 37 hypothetical Pareto-optimal outage schedules for Bowline Point Generating Station. Shaded bars indicate weeks of outage. The unique Pareto-optimal outcomes shown in Table 3 are differentiated by horizontal lines and are numbered at right.

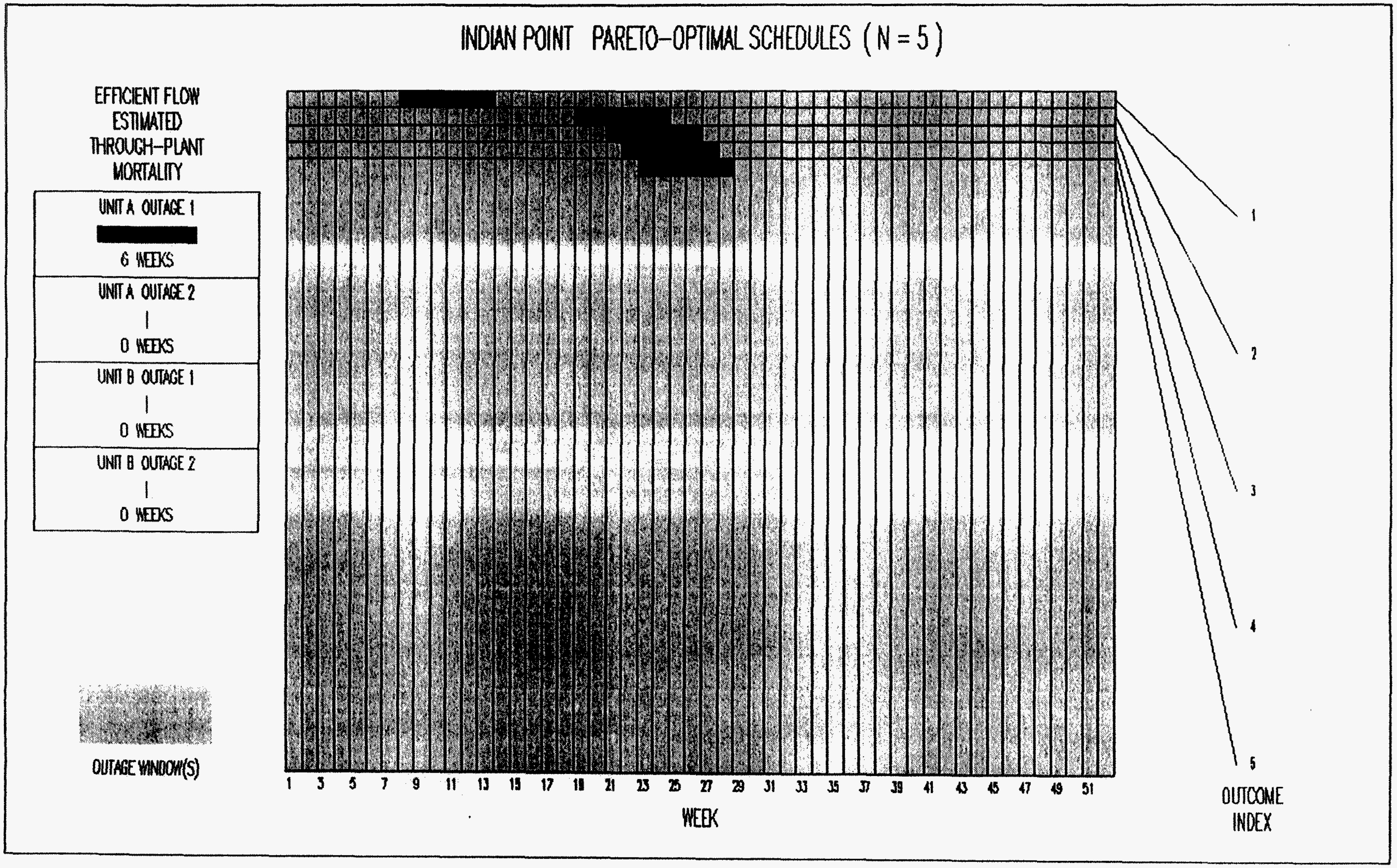

Figure 6. Set of 5 hypothetical Pareto-optimal outage schedules for Indian Point Generating Station. Shaded bars indicate weeks of outage. The unique Pareto-optimal outcomes shown in Table 5 are differentiated by horizontal lines and are numbered at right.

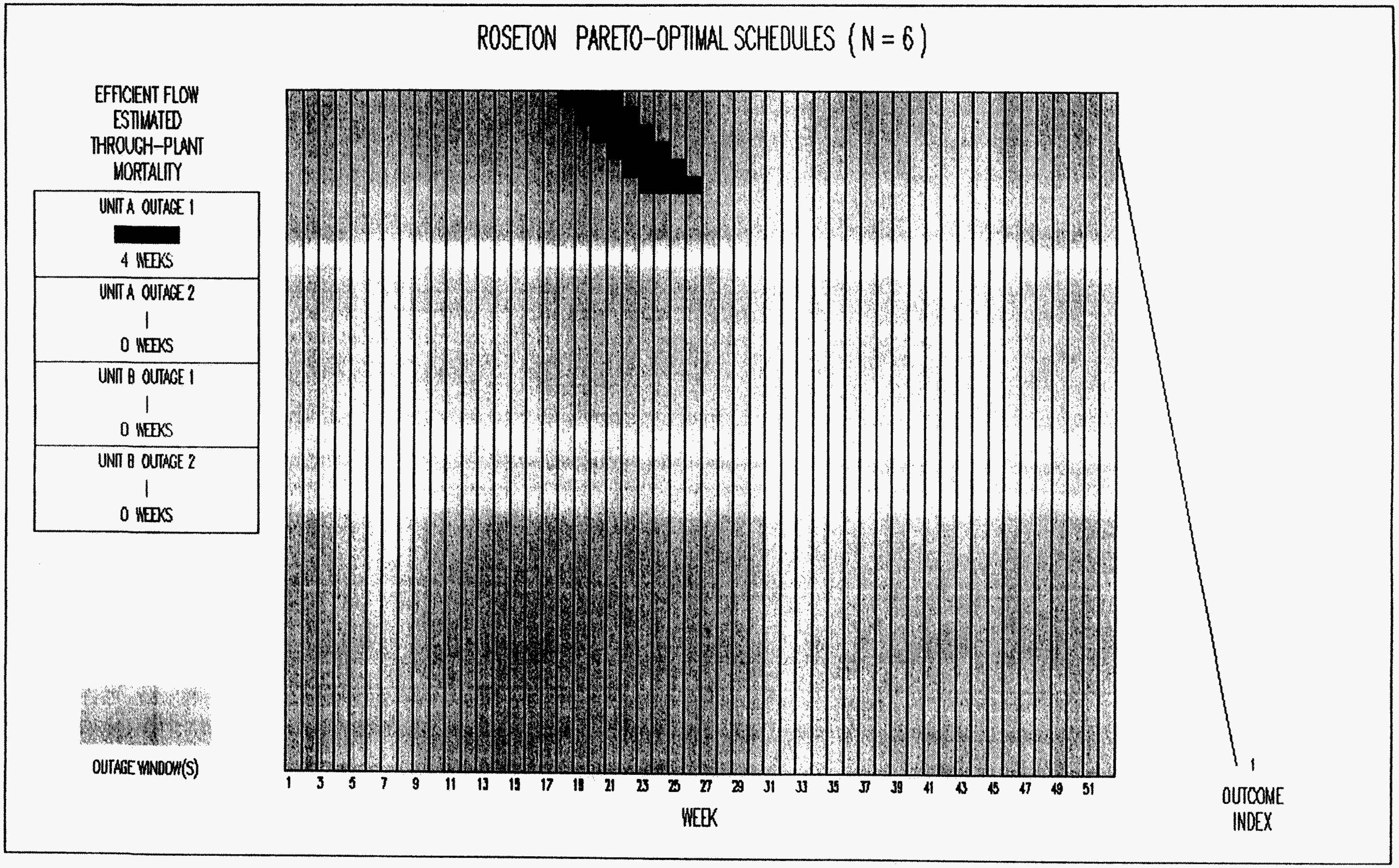

Figure 7. Set of 6 hypothetical Pareto-optimal outage schedules for Roseton Generating Station. Shaded bars indicate weeks of outage. The unique Pareto-optimal outcomes shown in Table 7 are differentiated by horizontal lines and are numbered at right.

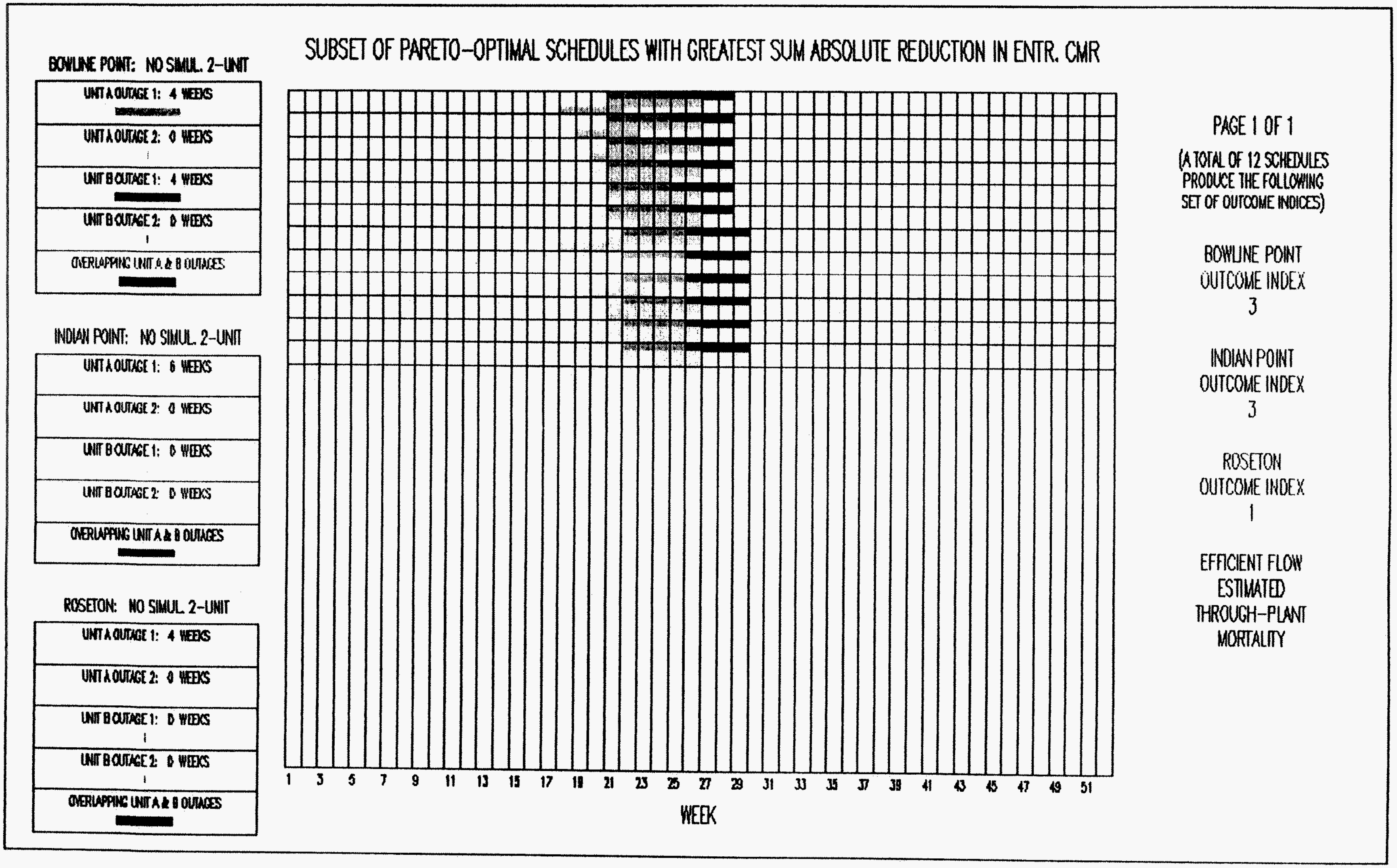

Figure 8. Subset of 60 hypothetical, combined schedules (for the three power plants: Bowline Point, Indian Point and Roseton) which satisfy the Pareto-optimality criteria and the criterion of greatest overall reduction in CMR.

Attachment 1. Minimum flows for efficient operation of Indian Point Units 2 and 3 by date.		
Date	Indian Point Unit 2 (1000's gal/min)	Indian Point Unit 3 (1000's gal/min)
1-Jan	504	513
2-Jan	504	518
3-Jan	504	521
4-Jan	504	519
5-Jan	504	518
6-Jan	504	515
7-Jan	504	516
8-Jan	504	509
9-Jan	504	512
10-Jan	504	511
11-Jan	504	511
12-Jan	504	510
13-Jan	504	510
14-Jan	504	510
15-Jan	504	508
16-Jan	504	508
17-Jan	504	509
18-Jan	504	510
19-Jan	504	510
20-Jan	504	509
21-Jan	504	506
22-Jan	504	506
23-Jan	504	507
24-Jan	504	505
25-Jan	504	506
26-Jan	504	504
27-Jan	504	505
28-Jan	504	507
29-Jan	504	504
30-Jan	504	504
31-Jan	504	504
1-Feb	504	505
2-Feb	504	505
3-Feb	504	504

Attachment 1. Minimum flows for efficient operation of Indian Point Units 2 and 3 by date.		
Date	Indian Point Unit 2 (1000's gal/min)	Indian Point Unit 3 (1000's gal/min)
4-Feb	504	502
5-Feb	504	501
6-Feb	504	502
7-Feb	504	501
8-Feb	504	503
9-Feb	504	501
10-Feb	504	501
11-Feb	504	498
12-Feb	504	501
13-Feb	504	501
14-Feb	504	303
15-Feb	504	500
16-Feb	504	499
17-Feb	504	500
18-Feb	504	497
19-Feb	504	498
20-Feb	504	498
21-Feb	504	502
22-Feb	504	503
23-Feb	504	502
24-Feb	504	504
25-Feb	504	501
26-Feb	504	504
27-Feb	504	510
28-Feb	504	508
29-Feb	504	508
1-Mar	504	508
2-Mar	504	507
3-Mar	504	504
4-Mar	504	504
5-Mar	504	507
6-Mar	504	507
7-Mar	504	507
8-Mar	504	510
9-Mar	504	514
10-Mar	504	511
11-Mar	504	514
12-Mar	504	511

Attachment 1. Minimum flows for efficient operation of Indian Point Units 2 and 3 by date.		
Date	Indian Point Unit 2 (1000's gal/min)	Indian Point Unit 3 (1000's gal/min)
13-Mar	504	514
14-Mar	504	521
15-Mar	504	525
16-Mar	504	526
17-Mar	504	529
18-Mar	560	531
19-Mar	504	528
20-Mar	560	531
21-Mar	560	536
22-Mar	560	540
23-Mar	560	542
24-Mar	560	546
25-Mar	560	547
26-Mar	560	549
27-Mar	560	554
28-Mar	560	556
29-Mar	560	560
30-Mar	560	568
31-Mar	560	581
1-Apr	616	587
2-Apr	616	589
3-Apr	616	592
4-Apr	616	591
5-Apr	616	588
6-Apr	616	591
7-Apr	616	596
8-Apr	616	604
9-Apr	616	603
10-Apr	616	606
11-Apr	616	610
12-Apr	616	611
13-Apr	616	617
14-Apr	616	622
15-Apr	616	628
16-Apr	616	628
17-Apr	616	632
18-Apr	672	642
19-Apr	672	646

Attachment 1. Minimum flows for efficient operation of Indian Point Units 2 and 3 by date.		
Date	Indian Point Unit 2 (1000's gal/min)	Indian Point Unit 3 (1000's gal/min)
20-Apr	672	655
21-Apr	672	665
22-Apr	672	670
23-Apr	672	676
24-Apr	672	685
25-Apr	672	681
26-Apr	672	687
27-Apr	728	692
28-Apr	728	699
29-Apr	728	702
30-Apr	728	710
1-May	728	714
2-May	784	719
3-May	784	725
4-May	784	734
5-May	784	746
6-May	784	759
7-May	784	786
8-May	784	789
9-May	784	799
10-May	840	812
11-May	840	825
12-May	840	832
13-May	840	840
14-May	840	841
15-May	840	841
16-May	840	841
17-May	840	842
18-May	840	842
19-May	840	843
20-May	840	843
21-May	840	844
22-May	840	844
23-May	840	844
24-May	840	844
25-May	840	844
26-May	840	845
27-May	840	846

Attachment 1. Minimum flows for efficient operation of Indian Point Units 2 and 3 by date.		
Date	Indian Point Unit 2 (1000's gal/min)	Indian Point Unit 3 (1000's gal/min)
28-May	840	847
29-May	840	847
30-May	840	847
31-May	840	847
1-Jun	840	847
2-Jun	840	849
3-Jun	840	849
4-Jun	840	850
5-Jun	840	850
6-Jun	840	850
7-Jun	840	850
8-Jun	840	850
9-Jun	840	851
10-Jun	840	851
11-Jun	840	851
12-Jun	840	852
13-Jun	840	852
14-Jun	840	852
15-Jun	840	852
16-Jun	840	852
17-Jun	840	853
18-Jun	840	853
19-Jun	840	853
20-Jun	840	854
21-Jun	840	854
22-Jun	840	855
23-Jun	840	855
24-Jun	840	855
25-Jun	840	856
26-Jun	840	856
27-Jun	840	857
28-Jun	840	857
29-Jun	840	857
30-Jun	840	857
1-Jul	840	857
2-Jul	840	858
3-Jul	840	858
4-Jul	840	858

Attachment 1. Minimum flows for efficient operation of Indian Point Units 2 and 3 by date.		
Date	Indian Point Unit 2 (1000's gal/min)	Indian Point Unit 3 (1000's gal/min)
5-Jul	840	858
6-Jul	840	859
7-Jul	840	859
8-Jul	840	859
9-Jul	840	859
10-Jul	840	859
11-Jul	840	860
12-Jul	840	860
13-Jul	840	861
14-Jul	840	861
15-Jul	840	861
16-Jul	840	861
17-Jul	840	861
18-Jul	840	861
19-Jul	840	862
20-Jul	840	862
21-Jul	840	862
22-Jul	840	862
23-Jul	840	863
24-Jul	840	863
25-Jul	840	863
26-Jul	840	863
27-Jul	840	863
28-Jul	840	864
29-Jul	840	864
30-Jul	840	863
31-Jul	840	863
1-Aug	840	863
2-Aug	840	864
3-Aug	840	864
4-Aug	840	864
5-Aug	840	864
6-Aug	840	864
7-Aug	840	864
8-Aug	840	864
9-Aug	840	864
10-Aug	840	865
11-Aug	840	864

Attachment 1. Minimum flows for efficient operation of Indian Point Units 2 and 3 by date.		
Date	Indian Point Unit 2 (1000's gal/min)	Indian Point Unit 3 (1000's gal/min)
12-Aug	840	864
13-Aug	840	864
14-Aug	840	864
15-Aug	840	864
16-Aug	840	864
17-Aug	840	864
18-Aug	840	863
19-Aug	840	864
20-Aug	840	864
21-Aug	840	863
22-Aug	840	863
23-Aug	840	863
24-Aug	840	863
25-Aug	840	863
26-Aug	840	863
27-Aug	840	863
28-Aug	840	863
29-Aug	840	863
30-Aug	840	863
31-Aug	840	862
1-Sep	840	862
2-Sep	840	862
3-Sep	840	862
4-Sep	840	862
5-Sep	840	862
6-Sep	840	862
7-Sep	840	861
8-Sep	840	861
9-Sep	840	861
10-Sep	840	860
11-Sep	840	860
12-Sep	840	860
13-Sep	840	860
14-Sep	840	860
15-Sep	840	859
16-Sep	840	859
17-Sep	840	858
18-Sep	840	858

Attachment 1. Minimum flows for efficient operation of Indian Point Units 2 and 3 by date.		
Date	Indian Point Unit 2 (1000's gal/min)	Indian Point Unit 3 (1000's gal/min)
19-Sep	840	858
20-Sep	840	858
21-Sep	840	857
22-Sep	840	857
23-Sep	840	856
24-Sep	840	856
25-Sep	840	855
26-Sep	840	855
27-Sep	840	855
28-Sep	840	854
29-Sep	840	854
30-Sep	840	854
1-Oct	840	853
2-Oct	840	853
3-Oct	840	853
4-Oct	840	852
5-Oct	840	851
6-Oct	840	851
7-Oct	840	851
8-Oct	840	850
9-Oct	840	849
10-Oct	840	849
11-Oct	840	849
12-Oct	840	848
13-Oct	840	848
14-Oct	840	847
15-Oct	840	847
16-Oct	840	846
17-Oct	840	847
18-Oct	840	847
19-Oct	840	846
20-Oct	840	845
21-Oct	840	844
22-Oct	840	844
23-Oct	840	843
24-Oct	840	843
25-Oct	840	843
26-Oct	840	842

Attachment 1. Minimum flows for efficient operation of Indian Point Units 2 and 3 by date.		
Date	Indian Point Unit 2 (1000's gal/min)	Indian Point Unit 3 (1000's gal/min)
27-Oct	840	841
28-Oct	840	841
29-Oct	840	841
30-Oct	840	841
31-Oct	840	841
1-Nov	840	840
2-Nov	840	805
3-Nov	840	814
4-Nov	840	817
5-Nov	840	805
6-Nov	784	769
7-Nov	784	782
8-Nov	784	782
9-Nov	784	768
10-Nov	784	737
11-Nov	728	717
12-Nov	784	720
13-Nov	784	717
14-Nov	728	714
15-Nov	728	711
16-Nov	728	702
17-Nov	728	694
18-Nov	672	690
19-Nov	672	682
20-Nov	672	674
21-Nov	672	676
22-Nov	672	671
23-Nov	672	665
24-Nov	672	654
25-Nov	672	646
26-Nov	672	644
27-Nov	616	638
28-Nov	616	638
29-Nov	616	632
30-Nov	616	628
1-Dec	616	619
2-Dec	616	615
3-Dec	616	606

Attachment 1. Minimum flows for efficient operation of Indian Point Units 2 and 3 by date.		
Date	Indian Point Unit 2 (1000's gal/min)	Indian Point Unit 3 (1000's gal/min)
4-Dec	616	601
5-Dec	616	592
6-Dec	616	595
7-Dec	616	593
8-Dec	616	587
9-Dec	560	579
10-Dec	560	571
11-Dec	560	559
12-Dec	560	555
13-Dec	560	558
14-Dec	560	553
15-Dec	560	550
16-Dec	560	549
17-Dec	560	548
18-Dec	560	544
19-Dec	560	538
20-Dec	560	539
21-Dec	560	534
22-Dec	560	530
23-Dec	504	529
24-Dec	504	528
25-Dec	504	528
26-Dec	504	521
27-Dec	504	522
28-Dec	504	522
29-Dec	504	522
30-Dec	504	521
31-Dec	504	520

Attachment 2a. Weekly contribution to annual CMR (average values as percent x 10) for 1991-1997 using estimated flow-through mortality rates.

Species	Outage Week	Roseton		Indian Point		Bowline Point	
		2-Unit Outage	1-Unit Outage	2-Unit Outage	1-Unit Outage	2-Unit Outage	1-Unit Outage
AT	1	0.0	0.0	0.0	0.0	0.0	0.0
AT	2	0.0	0.0	0.0	0.0	0.0	0.0
AT	3	0.0	0.0	0.0	0.0	0.0	0.0
AT	4	0.0	0.0	0.0	0.0	0.0	0.0
AT	5	0.0	0.0	0.0	0.0	0.0	0.0
AT	6	0.0	0.0	0.0	0.0	0.0	0.0
AT	7	0.0	0.0	0.0	0.0	0.0	0.0
AT	8	2.1	0.0	13.3	6.6	6.1	3.0
AT	9	4.8	0.0	19.3	9.6	8.6	4.3
AT	10	2.1	0.0	25.9	12.9	13.5	6.7
AT	11	2.1	0.0	24.3	12.1	12.2	6.1
AT	12	2.9	0.0	16.6	8.3	8.9	4.4
AT	13	1.9	0.0	8.5	4.2	6.0	3.0
AT	14	0.5	0.0	3.8	1.9	3.7	1.9
AT	15	0.1	0.0	7.2	3.6	4.1	2.0
AT	16	0.2	0.0	4.8	2.4	3.8	1.9
AT	17	0.2	0.0	7.5	3.7	4.7	2.3
AT	18	0.1	0.0	6.0	3.0	3.6	1.8
AT	19	0.1	0.0	8.4	4.3	3.3	1.7
AT	20	0.2	0.0	7.1	3.7	2.4	1.2
AT	21	0.4	0.1	9.5	4.9	2.7	1.3
AT	22	0.4	0.1	7.5	3.9	1.7	0.8
AT	23	0.1	0.0	3.0	1.6	0.5	0.2
AT	24	0.0	0.0	0.0	0.0	0.0	0.0
AT	25	0.0	0.0	0.0	0.0	0.0	0.0
AT	26	0.0	0.0	0.0	0.0	0.0	0.0
AT	27	0.0	0.0	0.0	0.0	0.0	0.0
AT	28	0.0	0.0	0.0	0.0	0.0	0.0
AT	29	0.0	0.0	0.0	0.0	0.0	0.0
AT	30	0.0	0.0	0.0	0.0	0.0	0.0
AT	31	0.0	0.0	0.0	0.0	0.0	0.0
AT	32	0.0	0.0	0.0	0.0	0.0	0.0
AT	33	0.0	0.0	0.0	0.0	0.0	0.0
AT	34	0.0	0.0	0.0	0.0	0.0	0.0
AT	35	0.0	0.0	0.0	0.0	0.0	0.0
AT	36	0.0	0.0	0.0	0.0	0.0	0.0

Species	Outage Week	Roseton		Indian Point		Bowline Point	
		2-Unit Outage	1-Unit Outage	2-Unit Outage	1-Unit Outage	2-Unit Outage	1-Unit Outage
AT	37	0.0	0.0	0.0	0.0	0.0	0.0
AT	38	0.0	0.0	0.0	0.0	0.0	0.0
AT	39	0.0	0.0	0.0	0.0	0.0	0.0
AT	40	0.0	0.0	0.0	0.0	0.0	0.0
AT	41	0.0	0.0	0.0	0.0	0.0	0.0
AT	42	0.0	0.0	0.0	0.0	0.0	0.0
AT	43	0.0	0.0	0.0	0.0	0.0	0.0
AT	44	0.0	0.0	0.0	0.0	0.0	0.0
AT	45	0.0	0.0	0.0	0.0	0.0	0.0
AT	46	0.0	0.0	0.0	0.0	0.0	0.0
AT	47	0.0	0.0	0.0	0.0	0.0	0.0
AT	48	0.0	0.0	0.0	0.0	0.0	0.0
AT	49	0.0	0.0	0.0	0.0	0.0	0.0
AT	50	0.0	0.0	0.0	0.0	0.0	0.0
AT	51	0.0	0.0	0.0	0.0	0.0	0.0
AT	52	0.0	0.0	0.0	0.0	0.0	0.0

Attachment 2a. Weekly contribution to annual CMR (average values as percent x 10) for 1991-1997 using estimated flow-through mortality rates. (continued)

Species	Outage Week	Roseton		Indian Point		Bowline Point	
		2-Unit Outage	1-Unit Outage	2-Unit Outage	1-Unit Outage	2-Unit Outage	1-Unit Outage
BA	1	0.0	0.0	0.0	0.0	0.0	0.0
BA	2	0.0	0.0	0.0	0.0	0.0	0.0
BA	3	0.0	0.0	0.0	0.0	0.0	0.0
BA	4	0.0	0.0	0.0	0.0	0.0	0.0
BA	5	0.0	0.0	0.0	0.0	0.0	0.0
BA	6	0.0	0.0	0.0	0.0	0.0	0.0
BA	7	0.0	0.0	0.0	0.0	0.0	0.0
BA	8	0.0	0.0	0.0	0.0	0.0	0.0
BA	9	0.0	0.0	0.0	0.0	0.0	0.0
BA	10	0.0	0.0	0.0	0.0	0.0	0.0
BA	11	0.0	0.0	0.0	0.0	0.0	0.0
BA	12	0.0	0.0	0.0	0.0	0.0	0.0
BA	13	0.0	0.0	0.0	0.0	0.0	0.0
BA	14	0.0	0.0	0.0	0.0	0.0	0.0
BA	15	0.0	0.0	0.0	0.0	0.0	0.0
BA	16	0.0	0.0	0.0	0.0	0.0	0.0
BA	17	0.0	0.0	0.0	0.0	0.0	0.0
BA	18	0.0	0.0	0.0	0.0	0.0	0.0
BA	19	0.0	0.0	0.4	0.2	0.1	0.1
BA	20	0.0	0.0	0.2	0.1	0.0	0.0
BA	21	0.0	0.0	1.3	0.6	0.2	0.1
BA	22	0.0	0.0	2.3	1.1	0.4	0.2
BA	23	0.0	0.0	7.3	3.6	1.4	0.7
BA	24	0.0	0.0	10.2	5.0	2.8	1.4
BA	25	0.2	0.1	20.6	10.2	5.4	2.7
BA	26	0.6	0.2	22.1	10.9	7.1	3.5
BA	27	1.7	0.6	28.1	13.9	7.7	3.8
BA	28	2.2	0.8	20.9	10.4	6.3	3.1
BA	29	1.5	0.5	14.7	7.3	5.2	2.6
BA	30	1.2	0.4	10.0	5.0	4.1	2.0
BA	31	1.3	0.4	8.1	4.0	3.3	1.6
BA	32	1.2	0.4	5.9	2.9	2.2	1.1
BA	33	0.8	0.3	3.3	1.6	1.1	0.6
BA	34	0.4	0.1	1.6	0.8	0.6	0.3
BA	35	0.1	0.0	1.0	0.5	0.4	0.2
BA	36	0.1	0.0	0.7	0.4	0.3	0.1

Species	Outage Week	Roseton		Indian Point		Bowline Point	
		2-Unit Outage	1-Unit Outage	2-Unit Outage	1-Unit Outage	2-Unit Outage	1-Unit Outage
BA	37	0.1	0.0	0.5	0.2	0.2	0.1
BA	38	0.0	0.0	0.2	0.1	0.1	0.0
BA	39	0.0	0.0	0.1	0.0	0.0	0.0
BA	40	0.0	0.0	0.0	0.0	0.0	0.0
BA	41	0.0	0.0	0.0	0.0	0.0	0.0
BA	42	0.0	0.0	0.0	0.0	0.0	0.0
BA	43	0.0	0.0	0.0	0.0	0.0	0.0
BA	44	0.0	0.0	0.0	0.0	0.0	0.0
BA	45	0.0	0.0	0.0	0.0	0.0	0.0
BA	46	0.0	0.0	0.0	0.0	0.0	0.0
BA	47	0.0	0.0	0.0	0.0	0.0	0.0
BA	48	0.0	0.0	0.0	0.0	0.0	0.0
BA	49	0.0	0.0	0.0	0.0	0.0	0.0
BA	50	0.0	0.0	0.0	0.0	0.0	0.0
BA	51	0.0	0.0	0.0	0.0	0.0	0.0
BA	52	0.0	0.0	0.0	0.0	0.0	0.0

Attachment 2a. Weekly contribution to annual CMR (average values as percent x 10) for 1991-1997 using estimated flow-through mortality rates. (continued)

Species	Outage Week	Roseton		Indian Point		Bowline Point	
		2-Unit Outage	1-Unit Outage	2-Unit Outage	1-Unit Outage	2-Unit Outage	1-Unit Outage
RH	1	0.0	0.0	0.0	0.0	0.0	0.0
RH	2	0.0	0.0	0.0	0.0	0.0	0.0
RH	3	0.0	0.0	0.0	0.0	0.0	0.0
RH	4	0.0	0.0	0.0	0.0	0.0	0.0
RH	5	0.0	0.0	0.0	0.0	0.0	0.0
RH	6	0.0	0.0	0.0	0.0	0.0	0.0
RH	7	0.0	0.0	0.0	0.0	0.0	0.0
RH	8	0.0	0.0	0.0	0.0	0.0	0.0
RH	9	0.0	0.0	0.0	0.0	0.0	0.0
RH	10	0.0	0.0	0.0	0.0	0.0	0.0
RH	11	0.0	0.0	0.0	0.0	0.0	0.0
RH	12	0.0	0.0	0.0	0.0	0.0	0.0
RH	13	0.0	0.0	0.0	0.0	0.0	0.0
RH	14	0.0	0.0	0.0	0.0	0.0	0.0
RH	15	0.0	0.0	0.0	0.0	0.0	0.0
RH	16	0.3	0.0	0.2	0.1	0.0	0.0
RH	17	0.5	0.0	1.6	0.8	0.2	0.1
RH	18	0.9	0.0	1.1	0.5	0.1	0.0
RH	19	1.6	0.2	1.0	0.5	0.1	0.0
RH	20	4.2	1.1	1.0	0.5	0.1	0.0
RH	21	3.9	1.0	0.7	0.3	0.1	0.0
RH	22	2.2	0.6	0.5	0.2	0.1	0.0
RH	23	3.4	0.9	1.0	0.5	0.2	0.1
RH	24	2.9	1.0	1.8	0.9	0.3	0.1
RH	25	2.3	0.8	1.0	0.5	0.1	0.1
RH	26	4.5	1.6	0.3	0.1	0.0	0.0
RH	27	4.0	1.5	0.1	0.1	0.0	0.0
RH	28	3.0	1.2	0.1	0.1	0.0	0.0
RH	29	1.3	0.5	0.2	0.1	0.0	0.0
RH	30	0.7	0.3	0.1	0.1	0.0	0.0
RH	31	0.4	0.2	0.0	0.0	0.0	0.0
RH	32	0.3	0.1	0.0	0.0	0.0	0.0
RH	33	0.1	0.0	0.0	0.0	0.0	0.0
RH	34	0.0	0.0	0.0	0.0	0.0	0.0
RH	35	0.0	0.0	0.0	0.0	0.0	0.0
RH	36	0.0	0.0	0.0	0.0	0.0	0.0

Species	Outage Week	Roseton		Indian Point		Bowline Point	
		2-Unit Outage	1-Unit Outage	2-Unit Outage	1-Unit Outage	2-Unit Outage	1-Unit Outage
RH	37	0.0	0.0	0.0	0.0	0.0	0.0
RH	38	0.0	0.0	0.0	0.0	0.0	0.0
RH	39	0.0	0.0	0.0	0.0	0.0	0.0
RH	40	0.0	0.0	0.0	0.0	0.0	0.0
RH	41	0.0	0.0	0.0	0.0	0.0	0.0
RH	42	0.0	0.0	0.0	0.0	0.0	0.0
RH	43	0.0	0.0	0.0	0.0	0.0	0.0
RH	44	0.0	0.0	0.0	0.0	0.0	0.0
RH	45	0.0	0.0	0.0	0.0	0.0	0.0
RH	46	0.0	0.0	0.0	0.0	0.0	0.0
RH	47	0.0	0.0	0.0	0.0	0.0	0.0
RH	48	0.0	0.0	0.0	0.0	0.0	0.0
RH	49	0.0	0.0	0.0	0.0	0.0	0.0
RH	50	0.0	0.0	0.0	0.0	0.0	0.0
RH	51	0.0	0.0	0.0	0.0	0.0	0.0
RH	52	0.0	0.0	0.0	0.0	0.0	0.0

Attachment 2a. Weekly contribution to annual CMR (average values as percent x 10) for 1991-1997 using estimated flow-through mortality rates. (continued)

Species	Outage Week	Roseton		Indian Point		Bowline Point	
		2-Unit Outage	1-Unit Outage	2-Unit Outage	l1-Unit Outage	2-Unit Outage	1-Unit Outage
SB	1	0.0	0.0	0.0	0.0	0.0	0.0
SB	2	0.0	0.0	0.0	0.0	0.0	0.0
SB	3	0.0	0.0	0.0	0.0	0.0	0.0
SB	4	0.0	0.0	0.0	0.0	0.0	0.0
SB	5	0.0	0.0	0.0	0.0	0.0	0.0
SB	6	0.0	0.0	0.0	0.0	0.0	0.0
SB	7	0.0	0.0	0.0	0.0	0.0	0.0
SB	8	0.0	0.0	0.0	0.0	0.0	0.0
SB	9	0.0	0.0	0.0	0.0	0.0	0.0
SB	10	0.0	0.0	0.0	0.0	0.0	0.0
SB	11	0.0	0.0	0.0	0.0	0.0	0.0
SB	12	0.0	0.0	0.0	0.0	0.0	0.0
SB	13	0.0	0.0	0.0	0.0	0.0	0.0
SB	14	0.0	0.0	0.0	0.0	0.0	0.0
SB	15	0.0	0.0	0.0	0.0	0.0	0.0
SB	16	0.0	0.0	0.0	0.0	0.0	0.0
SB	17	0.0	0.0	0.0	0.0	0.0	0.0
SB	18	0.7	0.0	0.1	0.1	0.0	0.0
SB	19	2.3	0.3	1.7	0.9	0.1	0.1
SB	20	3.7	1.0	6.4	3.2	0.4	0.2
SB	21	5.6	1.4	10.3	5.1	0.5	0.2
SB	22	6.0	1.5	18.3	9.1	0.9	0.5
SB	23	4.7	1.2	25.6	12.7	1.4	0.7
SB	24	4.9	1.6	23.5	11.7	1.6	0.8
SB	25	3.6	1.2	25.6	13.1	1.9	1.0
SB	26	3.2	1.1	13.3	6.8	0.9	0.5
SB	27	1.2	0.4	4.2	2.2	0.5	0.2
SB	28	0.6	0.2	1.2	0.6	0.2	0.1
SB	29	0.6	0.2	0.6	0.3	0.2	0.1
SB	30	0.3	0.1	0.3	0.2	0.1	0.0
SB	31	0.1	0.0	0.2	0.1	0.0	0.0
SB	32	0.0	0.0	0.0	0.0	0.0	0.0
SB	33	0.0	0.0	0.0	0.0	0.0	0.0
SB	34	0.0	0.0	0.0	0.0	0.0	0.0
SB	35	0.0	0.0	0.0	0.0	0.0	0.0
SB	36	0.0	0.0	0.0	0.0	0.0	0.0

Species	Outage Week	Roseton		Indian Point		Bowline Point	
		2-Unit Outage	1-Unit Outage	2-Unit Outage	I1-Unit Outage	2-Unit Outage	1-Unit Outage
SB	37	0.0	0.0	0.0	0.0	0.0	0.0
SB	38	0.0	0.0	0.0	0.0	0.0	0.0
SB	39	0.0	0.0	0.0	0.0	0.0	0.0
SB	40	0.0	0.0	0.0	0.0	0.0	0.0
SB	41	0.0	0.0	0.0	0.0	0.0	0.0
SB	42	0.0	0.0	0.0	0.0	0.0	0.0
SB	43	0.0	0.0	0.0	0.0	0.0	0.0
SB	44	0.0	0.0	0.0	0.0	0.0	0.0
SB	45	0.0	0.0	0.0	0.0	0.0	0.0
SB	46	0.0	0.0	0.0	0.0	0.0	0.0
SB	47	0.0	0.0	0.0	0.0	0.0	0.0
SB	48	0.0	0.0	0.0	0.0	0.0	0.0
SB	49	0.0	0.0	0.0	0.0	0.0	0.0
SB	50	0.0	0.0	0.0	0.0	0.0	0.0
SB	51	0.0	0.0	0.0	0.0	0.0	0.0
SB	52	0.0	0.0	0.0	0.0	0.0	0.0

Attachment 2a. Weekly contribution to annual CMR (average values as percent x 10) for 1991-1997 using estimated flow-through mortality rates. (continued)

Species	Outage Week	Roseton 2-Unit Outage	Roseton 1-Unit Outage	Indian Point 2-Unit Outage	Indian Point 1-Unit Outage	Bowline Point 2-Unit Outage	Bowline Point 1-Unit Outage
WP	1	0.0	0.0	0.0	0.0	0.0	0.0
WP	2	0.0	0.0	0.0	0.0	0.0	0.0
WP	3	0.0	0.0	0.0	0.0	0.0	0.0
WP	4	0.0	0.0	0.0	0.0	0.0	0.0
WP	5	0.0	0.0	0.0	0.0	0.0	0.0
WP	6	0.0	0.0	0.0	0.0	0.0	0.0
WP	7	0.0	0.0	0.0	0.0	0.0	0.0
WP	8	0.0	0.0	0.0	0.0	0.0	0.0
WP	9	0.0	0.0	0.0	0.0	0.0	0.0
WP	10	0.0	0.0	0.0	0.0	0.0	0.0
WP	11	0.0	0.0	0.0	0.0	0.0	0.0
WP	12	0.0	0.0	0.0	0.0	0.0	0.0
WP	13	0.0	0.0	0.0	0.0	0.0	0.0
WP	14	0.0	0.0	0.0	0.0	0.0	0.0
WP	15	0.0	0.0	0.0	0.0	0.0	0.0
WP	16	0.1	0.0	0.1	0.0	0.1	0.0
WP	17	0.5	0.0	0.3	0.2	0.1	0.1
WP	18	2.2	0.0	0.8	0.4	0.1	0.1
WP	19	7.6	1.0	1.5	0.7	0.1	0.0
WP	20	12.3	3.0	3.3	1.6	0.2	0.1
WP	21	13.3	3.4	5.1	2.5	0.3	0.1
WP	22	9.5	2.4	6.6	3.3	0.3	0.2
WP	23	7.7	2.0	9.0	4.5	0.5	0.2
WP	24	6.0	1.9	6.5	3.2	0.3	0.2
WP	25	3.7	1.3	5.7	2.9	0.4	0.2
WP	26	4.5	1.6	5.3	2.7	0.3	0.1
WP	27	3.1	1.1	5.3	2.7	0.2	0.1
WP	28	1.5	0.5	2.1	1.1	0.1	0.0
WP	29	0.7	0.2	1.1	0.6	0.1	0.0
WP	30	0.3	0.1	0.4	0.2	0.0	0.0
WP	31	0.2	0.1	0.1	0.1	0.0	0.0
WP	32	0.1	0.0	0.0	0.0	0.0	0.0
WP	33	0.1	0.0	0.0	0.0	0.0	0.0
WP	34	0.0	0.0	0.0	0.0	0.0	0.0
WP	35	0.0	0.0	0.0	0.0	0.0	0.0
WP	36	0.0	0.0	0.0	0.0	0.0	0.0

Species	Outage Week	Roseton		Indian Point		Bowline Point	
		2-Unit Outage	1-Unit Outage	2-Unit Outage	1-Unit Outage	2-Unit Outage	1-Unit Outage
WP	37	0.0	0.0	0.0	0.0	0.0	0.0
WP	38	0.0	0.0	0.0	0.0	0.0	0.0
WP	39	0.0	0.0	0.0	0.0	0.0	0.0
WP	40	0.0	0.0	0.0	0.0	0.0	0.0
WP	41	0.0	0.0	0.0	0.0	0.0	0.0
WP	42	0.0	0.0	0.0	0.0	0.0	0.0
WP	43	0.0	0.0	0.0	0.0	0.0	0.0
WP	44	0.0	0.0	0.0	0.0	0.0	0.0
WP	45	0.0	0.0	0.0	0.0	0.0	0.0
WP	46	0.0	0.0	0.0	0.0	0.0	0.0
WP	47	0.0	0.0	0.0	0.0	0.0	0.0
WP	48	0.0	0.0	0.0	0.0	0.0	0.0
WP	49	0.0	0.0	0.0	0.0	0.0	0.0
WP	50	0.0	0.0	0.0	0.0	0.0	0.0
WP	51	0.0	0.0	0.0	0.0	0.0	0.0
WP	52	0.0	0.0	0.0	0.0	0.0	0.0

Attachment 2b. Weekly contribution to annual CMR (averages value as percent x 10) for 1991-1997 using 100% flow-through mortality.

Species	Outage Week	Roseton		Indian Point		Bowline Point	
		2-Unit Outage	1-Unit Outage	2-Unit Outage	1-Unit Outage	2-Unit Outage	1-Unit Outage
AT	1	0.0	0.0	0.0	0.0	0.0	0.0
AT	2	0.0	0.0	0.0	0.0	0.0	0.0
AT	3	0.0	0.0	0.0	0.0	0.0	0.0
AT	4	0.0	0.0	0.0	0.0	0.0	0.0
AT	5	0.0	0.0	0.0	0.0	0.0	0.0
AT	6	0.0	0.0	0.0	0.0	0.0	0.0
AT	7	0.0	0.0	0.0	0.0	0.0	0.0
AT	8	3.0	0.0	19.4	9.6	8.9	4.4
AT	9	7.0	0.0	28.1	13.9	12.6	6.3
AT	10	3.1	0.0	37.7	18.7	19.7	9.8
AT	11	3.2	0.0	37.8	18.7	19.5	9.7
AT	12	4.3	0.0	27.3	13.6	15.1	7.5
AT	13	3.0	0.0	14.5	7.2	10.9	5.4
AT	14	0.9	0.0	7.4	3.7	7.5	3.7
AT	15	0.2	0.0	15.3	7.6	8.7	4.3
AT	16	0.4	0.0	10.3	5.1	8.0	4.0
AT	17	0.3	0.0	16.1	8.0	10.2	5.1
AT	18	0.3	0.0	13.0	6.4	7.9	3.9
AT	19	0.3	0.0	17.4	8.6	7.5	3.8
AT	20	0.5	0.1	14.7	7.3	5.4	2.7
AT	21	0.8	0.2	15.5	7.7	5.3	2.6
AT	22	0.7	0.2	12.1	6.0	3.4	1.7
AT	23	0.3	0.1	3.6	1.8	0.9	0.4
AT	24	0.0	0.0	0.0	0.0	0.0	0.0
AT	25	0.0	0.0	0.0	0.0	0.0	0.0
AT	26	0.0	0.0	0.0	0.0	0.0	0.0
AT	27	0.0	0.0	0.0	0.0	0.0	0.0
AT	28	0.0	0.0	0.0	0.0	0.0	0.0
AT	29	0.0	0.0	0.0	0.0	0.0	0.0
AT	30	0.0	0.0	0.0	0.0	0.0	0.0
AT	31	0.0	0.0	0.0	0.0	0.0	0.0
AT	32	0.0	0.0	0.0	0.0	0.0	0.0
AT	33	0.0	0.0	0.0	0.0	0.0	0.0
AT	34	0.0	0.0	0.0	0.0	0.0	0.0
AT	35	0.0	0.0	0.0	0.0	0.0	0.0
AT	36	0.0	0.0	0.0	0.0	0.0	0.0

Species	Outage Week	Roseton		Indian Point		Bowline Point	
		2-Unit Outage	1-Unit Outage	2-Unit Outage	1-Unit Outage	2-Unit Outage	1-Unit Outage
AT	37	0.0	0.0	0.0	0.0	0.0	0.0
AT	38	0.0	0.0	0.0	0.0	0.0	0.0
AT	39	0.0	0.0	0.0	0.0	0.0	0.0
AT	40	0.0	0.0	0.0	0.0	0.0	0.0
AT	41	0.0	0.0	0.0	0.0	0.0	0.0
AT	42	0.0	0.0	0.0	0.0	0.0	0.0
AT	43	0.0	0.0	0.0	0.0	0.0	0.0
AT	44	0.0	0.0	0.0	0.0	0.0	0.0
AT	45	0.0	0.0	0.0	0.0	0.0	0.0
AT	46	0.0	0.0	0.0	0.0	0.0	0.0
AT	47	0.0	0.0	0.0	0.0	0.0	0.0
AT	48	0.0	0.0	0.0	0.0	0.0	0.0
AT	49	0.0	0.0	0.0	0.0	0.0	0.0
AT	50	0.0	0.0	0.0	0.0	0.0	0.0
AT	51	0.0	0.0	0.0	0.0	0.0	0.0
AT	52	0.0	0.0	0.0	0.0	0.0	0.0

Attachment 2b. Weekly contribution to annual CMR (averages value as percent x 10) for 1991-1997 using 100% flow-through mortality. (continued)

Species	Outage Week	Roseton		Indian Point		Bowline Point	
		2-Unit Outage	1-Unit Outage	2-Unit Outage	1-Unit Outage	2-Unit Outage	1-Unit Outage
BA	1	0.0	0.0	0.0	0.0	0.0	0.0
BA	2	0.0	0.0	0.0	0.0	0.0	0.0
BA	3	0.0	0.0	0.0	0.0	0.0	0.0
BA	4	0.0	0.0	0.0	0.0	0.0	0.0
BA	5	0.0	0.0	0.0	0.0	0.0	0.0
BA	6	0.0	0.0	0.0	0.0	0.0	0.0
BA	7	0.0	0.0	0.0	0.0	0.0	0.0
BA	8	0.0	0.0	0.0	0.0	0.0	0.0
BA	9	0.0	0.0	0.0	0.0	0.0	0.0
BA	10	0.0	0.0	0.0	0.0	0.0	0.0
BA	11	0.0	0.0	0.0	0.0	0.0	0.0
BA	12	0.0	0.0	0.0	0.0	0.0	0.0
BA	13	0.0	0.0	0.0	0.0	0.0	0.0
BA	14	0.0	0.0	0.0	0.0	0.0	0.0
BA	15	0.0	0.0	0.0	0.0	0.0	0.0
BA	16	0.0	0.0	0.0	0.0	0.0	0.0
BA	17	0.0	0.0	0.0	0.0	0.0	0.0
BA	18	0.0	0.0	0.0	0.0	0.0	0.0
BA	19	0.0	0.0	0.4	0.2	0.1	0.1
BA	20	0.0	0.0	0.2	0.1	0.0	0.0
BA	21	0.0	0.0	1.3	0.6	0.2	0.1
BA	22	0.0	0.0	2.3	1.1	0.4	0.2
BA	23	0.0	0.0	7.3	3.6	1.4	0.7
BA	24	0.0	0.0	10.2	5.0	2.8	1.4
BA	25	0.2	0.1	20.6	10.2	5.4	2.7
BA	26	0.6	0.2	22.1	10.9	7.1	3.5
BA	27	1.7	0.6	28.1	13.9	7.7	3.8
BA	28	2.2	0.8	20.9	10.4	6.3	3.1
BA	29	1.5	0.5	14.7	7.3	5.2	2.6
BA	30	1.2	0.4	10.0	5.0	4.1	2.0
BA	31	1.3	0.4	8.1	4.0	3.3	1.6
BA	32	1.2	0.4	5.9	2.9	2.2	1.1
BA	33	0.8	0.3	3.3	1.6	1.1	0.6
BA	34	0.4	0.1	1.6	0.8	0.6	0.3
BA	35	0.1	0.0	1.0	0.5	0.4	0.2

Species	Outage Week	Roseton		Indian Point		Bowline Point	
		2-Unit Outage	1-Unit Outage	2-Unit Outage	1-Unit Outage	2-Unit Outage	1-Unit Outage
BA	36	0.1	0.0	0.7	0.4	0.3	0.1
BA	37	0.1	0.0	0.5	0.2	0.2	0.1
BA	38	0.0	0.0	0.2	0.1	0.1	0.0
BA	39	0.0	0.0	0.1	0.0	0.0	0.0
BA	40	0.0	0.0	0.0	0.0	0.0	0.0
BA	41	0.0	0.0	0.0	0.0	0.0	0.0
BA	42	0.0	0.0	0.0	0.0	0.0	0.0
BA	43	0.0	0.0	0.0	0.0	0.0	0.0
BA	44	0.0	0.0	0.0	0.0	0.0	0.0
BA	45	0.0	0.0	0.0	0.0	0.0	0.0
BA	46	0.0	0.0	0.0	0.0	0.0	0.0
BA	47	0.0	0.0	0.0	0.0	0.0	0.0
BA	48	0.0	0.0	0.0	0.0	0.0	0.0
BA	49	0.0	0.0	0.0	0.0	0.0	0.0
BA	50	0.0	0.0	0.0	0.0	0.0	0.0
BA	51	0.0	0.0	0.0	0.0	0.0	0.0
BA	52	0.0	0.0	0.0	0.0	0.0	0.0

Attachment 2b. Weekly contribution to annual CMR (averages value as percent x 10) for 1991-1997 using 100% flow-through mortality. (continued)

Species	Outage Week	Roseton		Indian Point		Bowline Point	
		2-Unit Outage	1-Unit Outage	2-Unit Outage	1-Unit Outage	2-Unit Outage	1-Unit Outage
RH	1	0.0	0.0	0.0	0.0	0.0	0.0
RH	2	0.0	0.0	0.0	0.0	0.0	0.0
RH	3	0.0	0.0	0.0	0.0	0.0	0.0
RH	4	0.0	0.0	0.0	0.0	0.0	0.0
RH	5	0.0	0.0	0.0	0.0	0.0	0.0
RH	6	0.0	0.0	0.0	0.0	0.0	0.0
RH	7	0.0	0.0	0.0	0.0	0.0	0.0
RH	8	0.0	0.0	0.0	0.0	0.0	0.0
RH	9	0.0	0.0	0.0	0.0	0.0	0.0
RH	10	0.0	0.0	0.0	0.0	0.0	0.0
RH	11	0.0	0.0	0.0	0.0	0.0	0.0
RH	12	0.0	0.0	0.0	0.0	0.0	0.0
RH	13	0.0	0.0	0.0	0.0	0.0	0.0
RH	14	0.0	0.0	0.0	0.0	0.0	0.0
RH	15	0.0	0.0	0.0	0.0	0.0	0.0
RH	16	0.4	0.0	0.2	0.1	0.0	0.0
RH	17	0.6	0.0	2.0	1.0	0.2	0.1
RH	18	1.1	0.0	1.3	0.7	0.1	0.1
RH	19	1.8	0.2	1.2	0.6	0.1	0.1
RH	20	4.6	1.2	1.2	0.6	0.1	0.1
RH	21	4.3	1.1	0.8	0.4	0.1	0.0
RH	22	2.6	0.7	0.6	0.3	0.1	0.0
RH	23	4.1	1.1	1.2	0.6	0.2	0.1
RH	24	3.7	1.2	2.2	1.1	0.3	0.2
RH	25	2.9	1.0	1.1	0.6	0.1	0.1
RH	26	5.3	1.8	0.3	0.1	0.0	0.0
RH	27	4.5	1.6	0.1	0.1	0.0	0.0
RH	28	3.1	1.1	0.1	0.1	0.0	0.0
RH	29	1.4	0.5	0.2	0.1	0.0	0.0
RH	30	0.7	0.3	0.1	0.1	0.0	0.0
RH	31	0.4	0.1	0.0	0.0	0.0	0.0
RH	32	0.3	0.1	0.0	0.0	0.0	0.0
RH	33	0.1	0.0	0.0	0.0	0.0	0.0
RH	34	0.0	0.0	0.0	0.0	0.0	0.0
RH	35	0.0	0.0	0.0	0.0	0.0	0.0

Specie s	Outage Week	Roseton		Indian Point		Bowline Point	
		2-Unit Outage	1-Unit Outage	2-Unit Outage	1-Unit Outage	2-Unit Outage	1-Unit Outage
RH	36	0.0	0.0	0.0	0.0	0.0	0.0
RH	37	0.0	0.0	0.0	0.0	0.0	0.0
RH	38	0.0	0.0	0.0	0.0	0.0	0.0
RH	39	0.0	0.0	0.0	0.0	0.0	0.0
RH	40	0.0	0.0	0.0	0.0	0.0	0.0
RH	41	0.0	0.0	0.0	0.0	0.0	0.0
RH	42	0.0	0.0	0.0	0.0	0.0	0.0
RH	43	0.0	0.0	0.0	0.0	0.0	0.0
RH	44	0.0	0.0	0.0	0.0	0.0	0.0
RH	45	0.0	0.0	0.0	0.0	0.0	0.0
RH	46	0.0	0.0	0.0	0.0	0.0	0.0
RH	47	0.0	0.0	0.0	0.0	0.0	0.0
RH	48	0.0	0.0	0.0	0.0	0.0	0.0
RH	49	0.0	0.0	0.0	0.0	0.0	0.0
RH	50	0.0	0.0	0.0	0.0	0.0	0.0
RH	51	0.0	0.0	0.0	0.0	0.0	0.0
RH	52	0.0	0.0	0.0	0.0	0.0	0.0

Attachment 2b. Weekly contribution to annual CMR (averages value as percent x 10) for 1991-1997 using 100% flow-through mortality. (continued)

Species	Outage Week	Roseton		Indian Point		Bowline Point	
		2-Unit Outage	1-Unit Outage	2-Unit Outage	1-Unit Outage	2-Unit Outage	1-Unit Outage
SB	1	0.0	0.0	0.0	0.0	0.0	0.0
SB	2	0.0	0.0	0.0	0.0	0.0	0.0
SB	3	0.0	0.0	0.0	0.0	0.0	0.0
SB	4	0.0	0.0	0.0	0.0	0.0	0.0
SB	5	0.0	0.0	0.0	0.0	0.0	0.0
SB	6	0.0	0.0	0.0	0.0	0.0	0.0
SB	7	0.0	0.0	0.0	0.0	0.0	0.0
SB	8	0.0	0.0	0.0	0.0	0.0	0.0
SB	9	0.0	0.0	0.0	0.0	0.0	0.0
SB	10	0.0	0.0	0.0	0.0	0.0	0.0
SB	11	0.0	0.0	0.0	0.0	0.0	0.0
SB	12	0.0	0.0	0.0	0.0	0.0	0.0
SB	13	0.0	0.0	0.0	0.0	0.0	0.0
SB	14	0.0	0.0	0.0	0.0	0.0	0.0
SB	15	0.0	0.0	0.0	0.0	0.0	0.0
SB	16	0.0	0.0	0.0	0.0	0.0	0.0
SB	17	0.0	0.0	0.1	0.0	0.0	0.0
SB	18	1.3	0.0	0.3	0.1	0.0	0.0
SB	19	4.8	0.7	5.8	2.9	0.5	0.2
SB	20	10.0	2.5	21.8	10.7	1.3	0.6
SB	21	17.2	4.3	35.0	17.2	1.7	0.9
SB	22	19.6	5.0	62.0	30.4	3.2	1.6
SB	23	15.7	4.1	86.2	42.1	4.8	2.4
SB	24	16.6	5.3	79.2	38.8	5.6	2.8
SB	25	12.4	4.3	79.8	39.0	6.7	3.3
SB	26	11.1	3.8	37.1	18.3	3.3	1.7
SB	27	4.3	1.5	13.3	6.6	1.8	0.9
SB	28	2.3	0.8	4.1	2.0	0.9	0.5
SB	29	2.2	0.8	2.1	1.1	0.6	0.3
SB	30	1.2	0.4	1.2	0.6	0.3	0.2
SB	31	0.3	0.1	0.5	0.3	0.1	0.1
SB	32	0.0	0.0	0.1	0.1	0.0	0.0
SB	33	0.0	0.0	0.0	0.0	0.0	0.0
SB	34	0.0	0.0	0.0	0.0	0.0	0.0
SB	35	0.0	0.0	0.0	0.0	0.0	0.0

Specie s	Outage Week	Roseton		Indian Point		Bowline Point	
		2-Unit Outage	1-Unit Outage	2-Unit Outage	1-Unit Outage	2-Unit Outage	1-Unit Outage
SB	36	0.0	0.0	0.0	0.0	0.0	0.0
SB	37	0.0	0.0	0.0	0.0	0.0	0.0
SB	38	0.0	0.0	0.0	0.0	0.0	0.0
SB	39	0.0	0.0	0.0	0.0	0.0	0.0
SB	40	0.0	0.0	0.0	0.0	0.0	0.0
SB	41	0.0	0.0	0.0	0.0	0.0	0.0
SB	42	0.0	0.0	0.0	0.0	0.0	0.0
SB	43	0.0	0.0	0.0	0.0	0.0	0.0
SB	44	0.0	0.0	0.0	0.0	0.0	0.0
SB	45	0.0	0.0	0.0	0.0	0.0	0.0
SB	46	0.0	0.0	0.0	0.0	0.0	0.0
SB	47	0.0	0.0	0.0	0.0	0.0	0.0
SB	48	0.0	0.0	0.0	0.0	0.0	0.0
SB	49	0.0	0.0	0.0	0.0	0.0	0.0
SB	50	0.0	0.0	0.0	0.0	0.0	0.0
SB	51	0.0	0.0	0.0	0.0	0.0	0.0
SB	52	0.0	0.0	0.0	0.0	0.0	0.0

Attachment 2b. Weekly contribution to annual CMR (averages value as percent x 10) for 1991-1997 using 100% flow-through mortality. (continued)

Specie s	Outage Week	Roseton		Indian Point		Bowline Point	
		2-Unit Outage	1-Unit Outage	2-Unit Outage	1-Unit Outage	2-Unit Outage	1-Unit Outage
WP	1	0.0	0.0	0.0	0.0	0.0	0.0
WP	2	0.0	0.0	0.0	0.0	0.0	0.0
WP	3	0.0	0.0	0.0	0.0	0.0	0.0
WP	4	0.0	0.0	0.0	0.0	0.0	0.0
WP	5	0.0	0.0	0.0	0.0	0.0	0.0
WP	6	0.0	0.0	0.0	0.0	0.0	0.0
WP	7	0.0	0.0	0.0	0.0	0.0	0.0
WP	8	0.0	0.0	0.0	0.0	0.0	0.0
WP	9	0.0	0.0	0.0	0.0	0.0	0.0
WP	10	0.0	0.0	0.0	0.0	0.0	0.0
WP	11	0.0	0.0	0.0	0.0	0.0	0.0
WP	12	0.0	0.0	0.0	0.0	0.0	0.0
WP	13	0.0	0.0	0.0	0.0	0.0	0.0
WP	14	0.0	0.0	0.0	0.0	0.0	0.0
WP	15	0.0	0.0	0.0	0.0	0.0	0.0
WP	16	0.2	0.0	0.2	0.1	0.1	0.0
WP	17	0.9	0.0	0.6	0.3	0.1	0.1
WP	18	3.6	0.0	1.3	0.6	0.1	0.1
WP	19	11.5	1.5	2.6	1.3	0.1	0.1
WP	20	19.4	4.8	5.8	2.9	0.3	0.2
WP	21	20.9	5.3	8.9	4.4	0.5	0.2
WP	22	15.5	3.9	11.7	5.8	0.6	0.3
WP	23	12.8	3.3	15.9	7.9	0.8	0.4
WP	24	10.2	3.3	11.4	5.7	0.6	0.3
WP	25	6.6	2.3	9.9	4.9	0.6	0.3
WP	26	8.0	2.8	8.6	4.3	0.5	0.3
WP	27	5.6	1.9	8.5	4.2	0.4	0.2
WP	28	2.7	0.9	3.3	1.7	0.2	0.1
WP	29	1.3	0.4	1.8	0.9	0.1	0.1
WP	30	0.6	0.2	0.7	0.3	0.0	0.0
WP	31	0.4	0.1	0.2	0.1	0.0	0.0
WP	32	0.3	0.1	0.0	0.0	0.0	0.0
WP	33	0.1	0.0	0.0	0.0	0.0	0.0
WP	34	0.0	0.0	0.0	0.0	0.0	0.0
WP	35	0.0	0.0	0.0	0.0	0.0	0.0

Species	Outage Week	Roseton		Indian Point		Bowline Point	
		2-Unit Outage	1-Unit Outage	2-Unit Outage	1-Unit Outage	2-Unit Outage	1-Unit Outage
WP	36	0.0	0.0	0.0	0.0	0.0	0.0
WP	37	0.0	0.0	0.0	0.0	0.0	0.0
WP	38	0.0	0.0	0.0	0.0	0.0	0.0
WP	39	0.0	0.0	0.0	0.0	0.0	0.0
WP	40	0.0	0.0	0.0	0.0	0.0	0.0
WP	41	0.0	0.0	0.0	0.0	0.0	0.0
WP	42	0.0	0.0	0.0	0.0	0.0	0.0
WP	43	0.0	0.0	0.0	0.0	0.0	0.0
WP	44	0.0	0.0	0.0	0.0	0.0	0.0
WP	45	0.0	0.0	0.0	0.0	0.0	0.0
WP	46	0.0	0.0	0.0	0.0	0.0	0.0
WP	47	0.0	0.0	0.0	0.0	0.0	0.0
WP	48	0.0	0.0	0.0	0.0	0.0	0.0
WP	49	0.0	0.0	0.0	0.0	0.0	0.0
WP	50	0.0	0.0	0.0	0.0	0.0	0.0
WP	51	0.0	0.0	0.0	0.0	0.0	0.0
WP	52	0.0	0.0	0.0	0.0	0.0	0.0

Attachment 3

The following is a proof of Pareto-optimality of plant-specific outcomes when the multiplicative combination of plant-specific outcomes is Pareto-optimal.

Definition: $\underline{C}^{*} = (C_{1}^{*}, C_{2}^{*}, \ldots, C_{k}^{*})$ is Pareto optimal over all $\underline{C}$ if $\exists$ no $\underline{C}^{**}$ such that
$C_{i}^{**} \leq C_{i}^{*} \; \forall \, i$ and,
$C_{i_0}^{**} < C_{i_0}^{*}$ for some i_0.

Let $\underline{C} = \underline{1} - \prod_{j=1}^{n} (\underline{1} - \underline{C}_j)$

$\underline{C}_j = (C_{j1}, C_{j2}, \ldots, C_{jk})$

$\underline{C} = \left(1 - \prod_{j=1}^{n} (1 - C_{j1}) \; , \ldots, 1 - \prod_{j=1}^{n} (1 - C_{jk}) \right)$

$= (C_{.1}, C_{.2}, \ldots, C_{.k})$.

Theorem: If $\underline{C}^{*} = \underline{1} - \prod_{j=1}^{n} (\underline{1} - \underline{C}_j^{*})$ is Pareto optimal over all $\underline{C}$, then $\underline{C}_j^{*}$ is Pareto optimal over all $\underline{C}_j$ $\forall \, j$.

Proof by contradiction:

Suppose $\underline{C}_j^{*}$ is not Pareto optimal over $\underline{C}_j \; \forall \, j$.

$\Rightarrow \exists \, j' \; with \; \underline{C}_{j'}^{**}$ such that $C_{j'i}^{**} \leq C_{j'i}^{*} \; \forall \, i$,
and $C_{j' i_0}^{**} < C_{j' i_0}^{*}$ for some i_0.

Let $\underline{C}^{**} = \underline{1} - [\prod_{j \neq j'}^{n} (\underline{1} - \underline{C}_j^{*})] (\underline{1} - \underline{C}_{j'}^{**})$

$\underline{C}^{**} = (C_{.1}^{**}, C_{.2}^{**}, \ldots, C_{.k}^{**})$

$$C_{.i}^{**} = 1 - [\prod_{j \neq j'}^{n} (1 - C_{ji}^{*})] (1 - C_{j'i}^{**}) \geq 1 - [\prod_{j \neq j'}^{n} (1 - C_{ji}^{*})] (1 - C_{ji}^{*}) = C_{.i}^{*} \; \forall \, i$$

since $C_{j'i}^{**} \leq C_{j'i}^{*} \; \forall \, i$,
and,

$$C^{**}_{\cdot i_0} = 1 - [\prod_{j \neq j'}^{n} (1 - C^{*}_{ji_0})]\,(1 - C^{**}_{j'i_0}) > 1 - [\prod_{j \neq j'}^{n} (1 - C^{*}_{ji_0})]\,(1 - C^{*}_{ji_0}) = C^{*}_{\cdot i_0}$$ for some i_0 ,

since $C^{**}_{j\,i_0} < C^{*}_{j\,i_0}$ for some i_0 .

$\Rightarrow C^{**}_{\cdot i} \leq C^{*}_{\cdot i}\ \forall\, i$

and,

$C^{**}_{\cdot i_0} < C^{*}_{\cdot i_0}$ for some i_0 .

$\Rightarrow \underline{C}^{*}$ is not Pareto optimal ..(a contradiction).

$\therefore \underline{C}^{*}_{j}$ is Pareto optimal over $\underline{C}_{j}\ \forall\, j$. QED.