AN EMPIRICAL ANALYSIS OF A SUBMARINE MOTION MODEL

by

R. N. Forrest and J. N. Eagle

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This report was prepared by:

R. N. Forrest
Professor of Operations Research

J. N. Eagle
Professor of Operations Research

Reviewed by:

Released by:

James N. Eagle, Chairman
ASW Academic Group

Paul J. Marto, Dean of Research
The report describes an empirical analysis of a submarine motion model that has been used in an ASW tactical decision aid. The primary conclusion from the analysis is that there are tactically reasonable submarine motions that may not be adequately described by the model.
The programs in this report are presented without representation or warranty of any kind.
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I. Introduction

This report describes an empirical analysis of a motion model that has been used to generate random submarine tracks for an ASW tactical decision aid. The model describes a submarine's motion as a series of transitions between the square cells of a grid that covers a defined operating region. A 3 X 3 transition matrix is associated with each cell of the grid which determines the submarine's transitions from a cell. The set of transition matrices define a Markov process. Despite its discrete nature, this Markov track generating process has been called a diffusion process in antisubmarine warfare tactical decision aid literature. The transition matrices are determined by tracks generated by an auxiliary stochastic process that is presumed to be of higher fidelity but more costly to implement than the Markov process.

The auxiliary track generating process that was used in the analysis is a random tour process that was developed to generate operationally realizable submarine tracks. The process, which is described in detail in Reference 1, generates random tracks that have specified end points and a specified length or, for a submarine with a constant track speed, a specified transit time. The auxiliary process is implemented by the program that is listed in Appendix 1.

The auxiliary tracks are the basis for the generation of two types of diffusion transition matrices by a procedure described in Section II. The first type, called static transition matrices, are the transition matrices that define the subject Markov motion
model. A static transition matrix is associated with each cell of the operating region grid. The second type, called dynamic transition matrices, define an alternate Markov motion model. This model differs from the subject model in that the transition matrix associated with a cell depends on the number of transitions that have taken place in the motion, that is, it is time dependent.

The auxiliary tracks are also the basis for the generation of a set of maps that describe a submarine's position at a sequence of equally spaced times that are determined by a fixed time step. The number of times a cell is occupied at the end of a time step divided by the number of tracks is an estimate of the probability that the submarine was within the cell at the time step. For this reason, such maps are called probability maps in the following discussion.

Tracks generated by the subject static diffusion Markov process and those generated by the alternate dynamic diffusion Markov process also can be used to generate probability maps. Some differences between the three track generating processes is evident by a comparison of the random tour probability maps, the dynamic diffusion probability maps and the static diffusion probability maps that are shown on the following pages.
II. The Transition Matrix Generation Procedure

The transition matrices that are used in the analysis were determined by the program listed in Appendix 1. In the program, a random tour track is generated by a submarine moving with constant speed between two points located in a plane. The points lie on the x-axis of a rectangular coordinate system whose origin is midway between the points. Lines parallel to the x-axis and lines parallel to the y-axis define a grid of square cells in the plane. (For examples of the program geometry, see Section V.) In the following discussion of the transition matrix determination procedure, grid cells are identified by the rectangular coordinates of their centers.

During its motion, the cell occupied by the submarine is determined at a sequence of times separated by a fixed time step. From this determination, transition matrices are constructed as follows: First, the cell that is occupied is determined for each time step. For \( I = 1 \) to \( NS \) (the number of time steps), if cell \((LO, MO)\) is occupied by the submarine at the end of the \( I-1^{st} \) time step, at the end of \( I^{th} \) time step, the submarine will be in a cell \((LO + N, MO + K)\) where \( N = -1, 0, \) or \( 1 \) and \( K = -1, 0, \) or \( 1 \). In this case, 1 is added to the \((N,K)\) element of a 3 X 3 transition matrix associated with cell \((LO,MO)\) for time \( I-1 \). The elements of this matrix are stored in an array \( MT(N, K, LO, MO, I-1) \). In addition, 1 is added to the \((N,K)\) element of a second 3 X 3 transition matrix associated with cell \((LO,MO)\). And, the elements of this matrix are stored in an array \( MTS(N, K, LO, MO) \). By
repeating this procedure for each random tour track, and dividing the resulting matrix elements by the number of tracks, the elements of the 3 X 3 matrix in the array MT become estimates of the elements of the dynamic transition matrix, and the elements of the matrix of the 3 X 3 matrix in the array MTS become estimates of the elements of the static transition matrix.

The transition matrices and the probability maps used in the analysis were generated from 10,000 random tour tracks. Since the time step duration is equal to the cell side length divided by the track generating submarine's speed; during a time step, the submarine will either transition to an adjacent cell or remain in its current cell. This results in a transition matrix of nine elements, each element giving the probability of a transition.
III. Some Comparisons of the Track Generating Processes

The dynamic and static transition matrices of the two discrete Markov track generating processes generate tracks that are random but differ in fine structure from those generated by the random tour process. This is not surprising considering the loss of information that occurs in their generation. Since the Markov motion is from a cell center to the cell center or a neighboring cell center, only nine motions are possible. In particular, for a submarine that moves with constant track speed, this results in a loss of position and velocity information. Relative to the auxiliary track generating process, the diffusion tracks no longer satisfy the constraints of constant speed, specified length and specified final end point.

The fidelity of the diffusion tracks could be improved in two ways: First, by reducing the duration of the time step and consequently the size of the cells, less positional information would be lost. Second, by generating a velocity (direction of motion) distribution for each cell and each time step, transition matrices could be constructed that would be more descriptive of the random tour motion and less directional information would be lost.
IV. Conclusions

The primary conclusion from the analysis is: For discrete Markov processes whose state space is current location and time, there are tactically reasonable submarine motion scenarios that cannot be closely approximated by tracks generated with static transition matrices but can be closely approximated with dynamic transition matrices. There are, however, other tactically reasonable submarine motion scenarios that cannot be closely approximated with either procedure. In what is possibly the simplest example of this, consider a submarine that moves among three adjacent cells labeled 1, 2 and 3. Suppose the submarine chooses either path (1,2,3) or path (3,2,1), each with probability \(\frac{1}{2}\). Given the submarine is in cell 2, the probability that the submarine will transition to cell 3 is dependent on its previous location as well as on its current location. Consequently, a Markov process whose state space is only current position and time cannot describe its motion.

For the random tour scenarios that were investigated, dynamic diffusion tracks were found to rather closely emulate the random tour tracks from which the dynamic transition matrices were derived. In addition, and in contrast to the static diffusion tracks, the dynamic diffusion tracks generated probability maps that duplicated the random tour probability maps. Although the static tracks were generally similar in appearance to the dynamic diffusion tracks, they did not uniformly terminate at the random tour track final end point. However, for the chosen scenario,
approximately half of the tracks did do so as is evident from the static diffusion probability maps that are shown in Section V.

The divergence between the dynamic diffusion probability maps and the static diffusion probability maps is even more evident when the initial point and final point of a track coincide. The explanation for this is the variation of the dynamic transition matrices with time. That is, the same cell must perform a "submarine expansion" function early in the motion and a "submarine contraction" function towards the end. But, when the starting and ending cells are distant from each other, the function of any cell does not change significantly with time. That is, cells near the start cell are for always for "expansion" and those near the end cell are always for "contraction."

The random tour process on which the empirical analysis is based was chosen to amplify the divergence between the random tour tracks, the dynamic diffusion tracks and the static diffusion tracks. The significance of this divergence for a tactical decision aid incorporating a motion model based on static transition matrices will depend on the desired applications of the decision aid. For example, it might be less significant if the location of the final end point of a submarine track were chosen randomly or if computer memory or processing speed limited modeling choices.
The figures in Section V that follows show probability maps and tracks generated by the random tour process, the dynamic Markov process transition matrices, and the static Markov process transition matrices. These figures illustrate the relative effectiveness of the dynamic and static Markov motion model in emulating the random tour motion model. The diffusion tracks that are shown were generated with 17 diffusions. This results in tracks that are approximately equal in length to the length the random tour tracks.
V. The Analysis Program Output

The figures, tables and maps that follow are based on data generated by the analysis program that is listed in Appendix 1. They provide the basis for the empirical analysis.
Figure 1. A track generated by a random tour process used in the analysis. The larger circles on the left and the right are the initial and final point of the track. The smaller circles are track positions at step times.
Figure 2. A superposition of 10,000 random tour tracks. These tracks determined the Markovian transition matrices that generated the diffusion probability maps that follow.
RANTRACK.BAS: random tour probability map

number of time steps = 0

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0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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submarine speed in knots = 10
distance between end points in nautical miles = 30
length of a cell side in nautical miles = 3
time step in hours = .3
maximum number of time steps = 17
track length in nautical miles = 50
delta in nautical miles = 5
leg length distribution index = 3
random number generator = standard
random number seed = 7351
number of tracks completed = 10000
number of tracks terminated = 0
cell entry sum = 10000
RANTRACK.BAS random tour probability map

```
number of time steps = 1

submarine speed in knots = 10
distance between end points in nautical miles = 30
length of a cell side in nautical miles = 3
time step in hours = .3
maximum number of time steps = 17
track length in nautical miles = 50
delta in nautical miles = 5
leg length distribution index = 3
random number generator = standard
random number seed = 7351
number of tracks completed = 10000
number of tracks terminated = 0
cell entry sum = 10000
```
RANTRACK.BAS: random tour probability map

number of time steps = 2

|       | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 0 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 0 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 0 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 0 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 0 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 0 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 0 0 | 12| 124| 233| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 0 1 | 84| 451| 1205| 814| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 0 4 | 136| 627| 1586| 1739| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 0 1 | 106| 456| 1223| 842| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 0 0 | 15| 130| 211| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 0 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 0 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 0 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 0 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 0 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 0 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

submarine speed in knots = 10
distance between end points in nautical miles = 30
length of a cell side in nautical miles = 3
time step in hours = .3
maximum number of time steps = 17
track length in nautical miles = 50
delta in nautical miles = 5
leg length distribution index = 3
random number generator = standard
random number seed = 7351
number of tracks completed = 10000
number of tracks terminated = 0
cell entry sum = 10000
RANTRACK.BAS random tour probability map

number of time steps = 3

submarine speed in knots = 10
distance between end points in nautical miles = 30
length of a cell side in nautical miles = 3
time step in hours = .3
maximum number of time steps = 17
track length in nautical miles = 50
delta in nautical miles = 5
leg length distribution index = 3
random number generator = standard
random number seed = 7351
number of tracks completed = 10000
number of tracks terminated = 0

cell entry sum = 10000
RANTRACK.BAS random tour probability map

number of time steps = 4

```
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0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
```

submarine speed in knots = 10
distance between end points in nautical miles = 50
length of a cell side in nautical miles = 3
time step in hours = .3
maximum number of time steps = 17
track length in nautical miles = 50
delta in nautical miles = 5
leg length distribution index = 3
random number generator = standard
random number seed = 7351
number of tracks completed = 10000
number of tracks terminated = 0
cell entry sum = 10000
RANTRACK.BAS random tour probability map

number of time steps = 5

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submarine speed in knots = 10
distance between end points in nautical miles = 30
length of cell side in nautical miles = 3
time step in hours = .3
maximum number of time steps = 17
track length in nautical miles = 50
delta in nautical miles = 5
leg length distribution index = 3
random number generator = standard
random number seed = 7351
number of tracks completed = 10000
number of tracks terminated = 0
cell entry sum = 10000
**RANTRACK.BAS random-tour probability map**

number of time steps = 3

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| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
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| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

submarine speed in knots = 10

distance between end points in nautical miles = 30

length of a cell side in nautical miles = 3

time step in hours = .3

maximum number of time steps = 17

track length in nautical miles = 50

delta in nautical miles = 5

leg length distribution index = 3

random number generator = standard

random number seed = 7351

number of tracks completed = 10000

number of tracks terminated = 0

cell entry sum = 10000
**RANTRACK.BAS: random track probability map**

number of time steps = 7

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Submarine speed in knots = 10
Distance between end points in nautical miles = 30
Length of a cell side in nautical miles = 3
Time step in hours = .3
Maximum number of time steps = 17
Track length in nautical miles = 50
Delta in nautical miles = 5
Leg length distribution index = 3
Random number generator = standard
Random number seed = 7351
Number of tracks completed = 10000
Number of tracks terminated = 0
Cell entry sum = 10000
RANTRACK.BAS random tour probability map

number of time steps = 8

submarine speed in knots = 10
distance between end points in nautical miles = 30
length of a cell side in nautical miles = 3
time step in hours = .3
maximum number of time steps = 17
track length in nautical miles = 50
delta in nautical miles = 5
leg length distribution index = 3
random number generator = standard
random number seed = 7351
number of tracks completed = 10000
number of tracks terminated = 0
cell entry sum = 10000
RANTRACIK.BAS random tour probability map

number of time steps = 9

| Time Step | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0         | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1         | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2         | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3         | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4         | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5         | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6         | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7         | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8         | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9         | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

submarine speed in knots = 10
distance between end points in nautical miles = 30
length of a cell side in nautical miles = 3
time step in hours = 0.3
maximum number of time steps = 17
track length in nautical miles = 50
delta in nautical miles = 5
leg length distribution index = 3
random number generator = standard
random number seed = 7351
number of tracks completed = 10000
number of tracks terminated = 0
cell entry sum = 10000
## RANTRACK.BAS - random tour probability map

**number of time steps**: 10

| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**submarine speed in knots**: 10
**distance between end points in nautical miles**: 30
**length of a cell side in nautical miles**: 3
**time step in hours**: .3
**maximum number of time steps**: 17
**track length in nautical miles**: 50
**delta in nautical miles**: 5
**random number generator index**: 3
**random number seed**: 7351
**number of tracks completed**: 10000
**number of tracks terminated**: 0
**cell entry sum**: 10000

22
RANTRACK.BAS: random tour probability map

number of time steps = 11

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0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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submarine speed in knots = 10
distance between endpoints in nautical miles = 30
length of a cell side in nautical miles = 3
time step in hours = .3
maximum number of time steps = 17
track length in nautical miles = 50
delta in nautical miles = 5
leg length distribution index = 3
random number generator = standard
random number seed = 7351
number of tracks completed = 10000
number of tracks terminated = 0
cell entry sum = 10000
RANTRACK.BAS random tour probability map

number of time steps = 12

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submarine speed in knots = 10
distance between end points in nautical miles = 30
length of a cell side in nautical miles = 3
time step in hours = .3
maximum number of time steps = 17
track length in nautical miles = 50
delta in nautical miles = 5
leg length distribution index = 3
random number generator = standard
random number seed = 7351
number of tracks completed = 10000
number of tracks terminated = 0
cell entry sum = 10000
RANTRACK.BAS - random tour probability map

number of time steps = 13

|     | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0   | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0   | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0   | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0   | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0   | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0   | 16 | 52 | 36 | 4 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0   | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0   | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0   | 530 | 676 | 465 | 471 | 207 | 60 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0   | 1046 | 546 | 629 | 696 | 452 | 91 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0   | 504 | 637 | 471 | 422 | 199 | 48 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0   | 18 | 69 | 25 | 10 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0   | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0   | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0   | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0   | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0   | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

submarine speed in knots = 10
distance between end points in nautical miles = 30
length of a cell side in nautical miles = 3
time step in hours = .3
maximum number of time steps = 17
track length in nautical miles = 50
delta in nautical miles = 5
leg length distribution index = 3
random number generator = standard
random number seed = 7351
number of tracks completed = 10000
number of tracks terminated = 0
cell entry sum = 10000
SRANTRACK.BAS:random tour probability.map

number of time steps = 14

|          | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0        | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0        | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0        | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0        | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0        | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0        | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0        | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0        | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0        | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0        | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0        | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0        | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

submarine speed in knots = 10
distance between end points in nautical miles = 30
length of a cell side in nautical miles = 3
time step in hours = .3
maximum number of time steps = 17
track length in nautical miles = 50
delta in nautical miles = 5
leg length distribution index = 3
random number generator = standard
random number seed = 7351
number of tracks completed = 10000
number of tracks terminated = 0
cell entry sum = 10000

26
RAOTRACK.BAS random tour probability map

number of time steps = 15

submarine speed in knots = 10
distance between end points in nautical miles = 30
length of a cell side in nautical miles = 3
time step in hours = .3
maximum number of time steps = 17
track length in nautical miles = 50
delta in nautical miles = 5
leg length distribution index = 3
random number generator = standard
random number seed = 7351
number of tracks completed = 10000
number of tracks terminated = 0
cell entry sum = 10000
RANTRACK.BAS random tour probability map

number of time steps = 16

```
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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0 0 0 0 0 0 0 0 0 0 1029 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 5536 1715 678 0 0 0
0 0 0 0 0 0 0 0 0 0 992 0 0 0 0 0 0
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submarine speed in knots = 10
distance between end points in nautical miles = 30
length of a cell side in nautical miles = 3
time step in hours = .3
maximum number of time steps = 17
track length in nautical miles = 50
delta in nautical miles = 5
leg length distribution index = 3
random number generator = standard
random number seed = 7351
number of tracks completed = 10000
number of tracks terminated = 0
cell entry sum = 10000
RAMTRACK.BAS random tour probability map

number of time steps = 17

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submarine speed in knots = 10
distance between end points in nautical miles = 30
length of a cell side in nautical miles = 3
time step in hours = .3
maximum number of time steps = 17
track length in nautical miles = 50
delta in nautical miles = 5
leg length distribution index = 3
random number generator = standard
random number seed = 7351
number of tracks completed = 10000
number of tracks terminated = 0
cell entry sum = 10000
Table I. A dynamic diffusion transition matrix that was used to generate the dynamic diffusion map for 1 transition.

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<th>RANTRACK.BAS dynamic transition matrix</th>
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<tr>
<td>transition number = 1</td>
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<tr>
<td>x = -5</td>
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<tr>
<td>y = 0</td>
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<tr>
<td></td>
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<tr>
<td>87 1161 961</td>
</tr>
<tr>
<td>316 1561 3733</td>
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<tr>
<td>80 1133 968</td>
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<td>submarine speed in knots = 10</td>
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<td>random number generator = standard</td>
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<td>random number seed = 7351</td>
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<tr>
<td>number of tracks completed = 10000</td>
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<tr>
<td>number of tracks terminated = 0</td>
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</tbody>
</table>

30
Figure 3 A track generated by a dynamic process. The dynamic transition matrices were determined by the random tour tracks shown in Figure 2. The number of diffusions is 17. The circles are defined in Figure 1.
Figure 4 A superposition of 10,000 dynamic diffusion tracks. Their dynamic transition matrices were determined by the random tour tracks shown in Figure 2. The number of diffusions is 17. The circles are defined in Figure 1.
.RAMTRACK:BAS dynamic diffusion probability map

number of diffusions = 0

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

submarine speed in knots = 10
distance between end points in nautical miles = 30
length of a cell side in nautical miles = 3
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maximum number of time steps = 17
track length in nautical miles = 50
delta in nautical miles = 5
leg length distribution index = 3
random number generator = standard
random number seed = 7351
number of tracks completed = 10000
number of tracks terminated = 0
cell entry sum = 10000

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RANTRACK.BAS: dynamic diffusion probability map

number of diffusions = 1

submarine speed in knots = 10

distance between end points in nautical miles = 30

length of a cell side in nautical miles = 3

time step in hours = .3

maximum number of time steps = 17

track length in nautical miles = 50

delta in nautical miles = 5

leg length distribution index = 3

random number generator = standard

random number seed = 7351

number of tracks completed = 10000

number of tracks terminated = 0

cell entry sum = 10000
number of diffusions = 2

submarine speed in knots = 10
distance between end points in nautical miles = 30
length of a cell side in nautical miles = 3
time step in hours = .3
maximum number of time steps = 17
track length in nautical miles = 50
delta in nautical miles = 5
leg length distribution index = 3
random number generator = standard
random number seed = 7351
number of tracks completed = 10000
number of tracks terminated = 0

cell entry sum = 10000
RANTRAC. BAS dynamic diffusion probability map

number of diffusions = 3

| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 17 | 28 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 16 | 101 | 236 | 335 | 17 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 2 | 33 | 228 | 637 | 994 | 541 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 5 | 54 | 516 | 619 | 1042 | 521 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

submarine speed in knots = 10

distance-between end points in nautical miles = 30

length of a cell side in nautical miles = 3

time step in hours = .3

maximum number of time steps = 17

track length in nautical miles = 50

delta in nautical miles = 5

leg length distribution index = 3

random number generator = standard

random number seed = 7351

number of tracks completed = 10000

number of tracks terminated = 0

cell entry sum = 10000

36
RANTRACK.BAS: dynamic diffusion probability map.

Number of diffusions = 4.

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0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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0 0 0 0 0 1 2 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 3 16 42 54 22 0 0 0 0 0 0 0 0 0 0 0
0 0 0 8 45 176 272 309 20 0 0 0 0 0 0 0 0 0 0 0 0
0 0 3 22 126 337 722 832 294 0 0 0 0 0 0 0 0 0 0 0 0
0 0 6 31 177 449 949 1175 485 0 0 0 0 0 0 0 0 0 0 0 0
0 0 5 29 126 377 746 859 271 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 17 61 137 307 315 29 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 1 15 29 61 32 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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Submarine speed in knots = 10
Distance between end points in nautical miles = 30
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Track length in nautical miles = 50
Delta in nautical miles = 5
Leg length distribution index = 3
Random number generator = standard
Random number seed = 7351
Number of tracks completed = 10000
Number of tracks terminated = 0
Cell entry sum = 10000
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- submarine speed in knots = 10
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- random number seed = 7351
- number of tracks completed = 10000
- number of tracks terminated = 0
- cell entry sum = 10000
RANTRACK.BAS dynamic diffusion probability map

number of diffusions = 6

| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

submarine speed in knots = 10
distance between end points in nautical miles = 30
length of a cell side in nautical miles = 3
time step in hours = 0.3
maximum number of time steps = 17
track length in nautical miles = 50
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leg length distribution index = 3
random number generator = standard
random number seed = 7351
number of tracks completed = 10000
number of tracks terminated = 0
cell entry sum = 10000

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## RANTRACK.BAS dynamic diffusion probability map

number of diffusions = 7

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submarine speed in knots = 10
distance between end points in nautical miles = 30
length of a cell side in nautical miles = 3
time step in hours = .3
maximum number of time steps = 17
track length in nautical miles = 50
delta in nautical miles = 5
leg length distribution index = 3
random number generator = standard
random number seed = 7351
number of tracks completed = 10000
number of tracks terminated = 0
cell entry sum = 10000
RANTRACK: Dynamic diffusion probability map

Number of diffusions = 8

| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Submarine speed in knots = 10
Distance between end points in nautical miles = 30
Length of a cell side in nautical miles = 3
Time step in hours = .3
Maximum number of time steps = 17
Track length in nautical miles = 50
Delta in nautical miles = 5
Leg length distribution index = 3
Random number generator = standard
Random number seed = 7351
Number of tracks completed = 10000
Number of tracks terminated = 0
Cell entry sum = 10000
RAMTRACK.BAS  

dynamic-diffusion probability map.

`number of diffusions = 9`

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</table>

```

submarine speed in knots = 10

distance between end points in nautical miles = 30

length of a cell side in nautical miles = 3

time step in hours = .3

maximum number of time steps = 17

track length in nautical miles = 50

delta in nautical miles = 5

leg length distribution index = 3

random number generator = standard

random number seed = 7351

number of tracks completed = 10000

number of tracks terminated = 0

cell entry sum = 10000
**RANTRACK.BAS** dynamic diffusion-probability map

- number of diffusions: 10

| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
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| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Submarine speed in knots = 10
Distance between end points in nautical miles = 30
Length of a cell side in nautical miles = 3
Time step in hours = .3
Maximum number of time steps = 17
Track length in nautical miles = 50
Delta in nautical miles = 5
Leg length distribution index = 3
Random number generator = standard
Random number seed = 7351
Number of tracks completed = 10000
Number of tracks terminated = 0
Cell entry sum = 10000
RANTRACK.BAS: dynamic-diffusion-probability-map

number of diffusions = 11

| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

submarine speed in knots = 10

distance between end points in nautical miles = 30

length of a cell side in nautical miles = 3

time step in hours = .3

maximum number of time steps = 17

track length in nautical miles = 50

delta in nautical miles = 5

leg length distribution index = 3

random number generator = standard

random number seed = 7351

number of tracks completed = 10000

number of tracks terminated = 0

cell entry sum = 10000

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RANTRACK.BAS: dynamic diffusion probability map

number of diffusions = 12

```
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
```

submarine speed in knots = 10
distance between end points in nautical miles = 30
length of a cell side in nautical miles = 3
time step in hours = .3
maximum number of time steps = 17
track length in nautical miles = 50
delta in nautical miles = 5
leg length distribution index = 3
random number generator = standard
random number seed = 7351
number of tracks completed = 10000
number of tracks terminated = 0
cell entry sum = 10000
RANTRACK.BAS dynamic diffusion probability map

number of diffusions = 13

```
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
```

submarine speed in knots = 10

distance between end points in nautical miles = 30

length of a cell side in nautical miles = 3

time step in hours = .3

maximum number of time steps = 17

track length in nautical miles = 50

delta in nautical miles = 5

leg length distribution index = 3

random number generator = standard

random number seed = 7351

number of tracks completed = 10000

number of tracks terminated = 0

cell entry sum = 10000
RANTRACK BAS dynamic diffusion probability map

number of diffusions = .14

submarine speed in knots = 10
distance between end points in nautical miles = 30
length of a cell side in nautical miles = 3
time step in hours = .3
maximum number of time steps = 17
track length in nautical miles = 50
delta in nautical miles = 5
leg length distribution index = 3
random number generator = standard
random number seed = 7351
number of tracks completed = 10000
number of tracks terminated = 0
cell entry sum = 10000
RANTRACK.BAS dynamic diffusion probability map

number of diffusions = 15

|                     | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.0                 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.0                 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.0                 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.0                 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.0                 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.0                 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.0                 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.0                 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.0                 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.0                 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.0                 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.0                 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.0                 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

submarine speed in knots = 10

distance between endpoints in nautical miles = 30

length of a cell side in nautical miles = 3

time step in hours = .3

maximum number of time steps = 17

track length in nautical miles = 50

delta in nautical miles = 5

leg length distribution index = 3

random number generator = standard

random number seed = 7351

number of tracks completed = 10000

number of tracks terminated = 0

cell entry sum = 10000
### RANTRACK parameter settings and diffusion probability map

```
number of diffusions = 16

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
```

Distance between end points in nautical miles: 30
Time step in hours: 3
Maximum number of time steps: 17
Track length in nautical miles: 50
Delta in nautical miles: 5
Leg length distribution index: 3
Random number generator: standard
Random number seed: 7351
Number of tracks completed: 10000
Number of tracks terminated: 0
Cell entry sum: 10000
RAIMTRACK.BAS dynamic diffusion probability map.

number of diffusions = 37

submarine speed in knots = 10
distance between end points in nautical miles = 30
length of a cell side in nautical miles = 3
time step in hours = .3
maximum number of time steps = 17
track length in nautical miles = 50
delta in nautical miles = 5'
leg length distribution index = 3
random number generator = standard
random number seed = 7351
number of tracks completed = 10000
number of tracks terminated = 0
cell entry sum = 10000
Table II. A static diffusion transition matrix that was used to generate the static diffusion maps.

<table>
<thead>
<tr>
<th>RANTRACK.BAS static transition matrix</th>
</tr>
</thead>
<tbody>
<tr>
<td>( x = -5 )</td>
</tr>
<tr>
<td>( y = 0 )</td>
</tr>
<tr>
<td>107   1407   1290</td>
</tr>
<tr>
<td>375   2008   4848</td>
</tr>
<tr>
<td>99    1389   1332</td>
</tr>
</tbody>
</table>

submarine speed in knots = 10  
distance between end points in nautical miles = 30  
length of a cell side in nautical miles = 3  
time step in hours = .3  
maximum number of time steps = 17  
track length in nautical miles = 50  
delta in nautical miles = 5  
leg length distribution index = 3  
random number generator = standard  
random number seed = 7351  
number of tracks completed = 10000  
number of tracks terminated = 0
Figure 5 A track generated by a static diffusion process. The static transition matrices were determined by the random tour tracks shown in Figure 2. The number of diffusions is 17. The circles are defined in Figure 1.
**Figure 6** A superposition of 10,000 static diffusion tracks. Their static transition matrices were determined by the random tour tracks shown in Figure 2. The number of diffusions is 17. The circles are defined in Figure 1.
RANTRACK: BAS static diffusion probability map

number of diffusions = 0.

0.0000000000000000000000000000000000000000000000000000000000000000
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0.0000000000000000000000000000000000000000000000000000000000000000

submarine speed in knots = 10

distance between end points in nautical miles = 30

length of a cell side in nautical miles = 3

timestep in hours = .3

maximum number of time steps = 17

track length in nautical miles = 50

delta in nautical miles = 5

leg length distribution index = 3

random number generator = standard

random number seed = 7351

number of tracks completed = 10000

number of tracks terminated = 0


cell entry sum = 10000


cell entries are rounded integer

54
RANTRACK.BAS static diffusion probability map

number of diffusions = 1

submarine speed in knots = 10
distance between end points in nautical miles = 30
length of a cell side in nautical miles = 3
time step in hours = .3
maximum number of time steps = 17
track length in nautical miles = 50
delta in nautical miles = 5
leg length distribution index = 3
random number generator = standard
random number seed = 7351
number of tracks completed = 10000
number of tracks terminated = 0
cell entry sum = 10000
cell entries are rounded integer
RANTRACK.BAS: static diffusion probability map

number of diffusions = 2

submarine speed in knots = 10
distance between end points in nautical miles = 30
length of a cell side in nautical miles = 3
time step in hours = .3
maximum number of time steps = 17.
track length in nautical miles = 50
delta in nautical miles = 5
leg length distribution index = 3
random number generator = standard
random number seed = 7351
number of tracks completed = 10000
number of tracks terminated = 0

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RAMTRACK.BAS static diffusion probability map

number of diffusions = 3.

[subsequent data table follows]

submarine speed in knots = 10
distance between end points in nautical miles = 30
length of a cell side in nautical miles = 3

time step in hours = .3
maximum number of time steps = 17
track length in nautical miles = 50
delta in nautical miles = .5
leg length distribution index = 3
random number generator = standard
random number seed = 7351
number of tracks completed = 10000
number of tracks terminated = 0

cell entry sum = 10000

cell entries are rounded integer
RANTRACK.BAS: static diffusion probability map

Number of diffusions = 4

| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Submarine speed in knots = 10
Distance between end points in nautical miles = 30
Length of a cell side in nautical miles = 3
Time step in hours = .3
Maximum number of time steps = 3
Track length in nautical miles = 50
Delta in nautical miles = 5
Leg length distribution index = 3
Random number generator = standard
Random number seed = 7351
Number of tracks completed = 10000
Number of tracks terminated = 0
Cell entry sum = 10000
Cell entries are rounded integer
RANTRACK.BAS static diffusion probability map

Number of diffusions = 5

|          | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0        | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1        | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2        | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3        | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4        | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5        | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6        | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7        | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8        | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9        | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Submarine speed in knots = 10
Distance between end points in nautical miles = 30
Length of a cell side in nautical miles = 3
Time step in hours = .3
Maximum number of time steps = 17
Track length in nautical miles = 50
Delta in nautical miles = 5
Leg length distribution index = 3
Random number generator = standard
Random number seed = 7351
Number of tracks completed = 10000
Number of tracks terminated = 0
Cell entry sum = 10000
Cell entries are rounded integer
RANTRACK.BAS static diffusion probability map

- number of diffusions = 6

| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Submarine speed in knots = 10
Distance between end points in nautical miles = 30
Length of a cell side in nautical miles = 3
Time step in hours = .3
Maximum number of time steps = 17
Track length in nautical miles = 50
Delta in nautical miles = 5
Leg-length distribution index = 3
Random number generator = standard
Random number seed = 7351
Number of tracks completed = 10000
Number of tracks terminated = 0
Cell entry sum = 10000
Cell entries are rounded integer
RANTRACK : BAS static diffusion probability map.

number of diffusions = 7

submarine speed in knots = 10
distance between end points in nautical miles = 30
length of a cell side in nautical miles = 3
time step in hours = .3
maximum number of time steps = 17
track length in nautical miles = 50
delta in nautical miles = 5
leg length distribution index = 3
random number generator = standard
random number seed = 7351
number of tracks completed = 10000
number of tracks terminated = 0

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RANTRACK.BAS: static diffusion: probability map

number of diffusions = 8

|         | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
|         | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
|         | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
|         | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
|         | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
|         | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
|         | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
|         | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
|         | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

submarine speed in knots = 10

distance between end points in nautical miles = 30

length of a cell side in nautical miles = 3

time step in hours = .3

maximum number of time steps = 17

track length in nautical miles = 50

delta in nautical miles = 5

cell length distribution index = 3

random number generator = standard

random number seed = 7351

number of tracks completed = 10000

number of tracks terminated = 0

cell entry sum = 9999.999

cell entries are rounded integer
```
number of diffusions = 9

| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

submarine speed in knots = 10
distance between end points in nautical miles = 30
length of a cell side in nautical miles = 3
time step in hours = .3
maximum number of time steps = 17
track length in nautical miles = 50
delta in nautical miles = 5
leg length distribution index = 3
random number generator = standard
random number seed = 7351
number of tracks completed = 10000
number of tracks terminated = 0
cell entry sum = 10000
cell entries are rounded integer
```
RANTRACK.BAS: static diffusion probability map

number of diffusions: 10:

| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

submarine speed in knots = 10

distance between end points in nautical miles = 30

length of a cell side in nautical miles = 3

time step in hours = .3

maximum number of time steps = 17

track length in nautical miles = 50

delta in nautical miles = 5

leg length distribution index = 3

random number generator = standard

random number seed = 7351

number of tracks completed = 10000

number of tracks terminated = 0

number of tracks completed

cell entry sum = 9999.999

cell entries are rounded integer
RAWTRACK.BAS static diffusion probability map

number of diffusions = 11

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submarine speed in knots = 10
distance between endpoints in nautical miles = 30
length of cell side in nautical miles = 3
time step in hours = .3
maximum number of time steps = 17
track length in nautical miles = 50
delta in nautical miles = 5
leg length distribution index = 3
random number generator = standard
random number seed = 7351
number of tracks completed = 10000
number of tracks terminated = 0
cell entry sum = 9999.999

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**RANTRAC** static diffusion probability map

Number of diffusions = 12

| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Submarine speed in knots = 10
Distance between end points in nautical miles = 30
Length of a cell side in nautical miles = 3
Maximum number of time steps = 17
Track length in nautical miles = 50
Time step in hours = .3
Delta in nautical miles = 5
Leg length distribution index = 3
Random number generator = standard
Random number seed = 7351
Number of tracks completed = 10000
Number of tracks terminated = 0
Cell entry sum = 10000
Cell entries are rounded integer
RANTRACK.BAS: static diffusion probability map

number of diffusions = 13

| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

submarine speed in knots = 10

distance between end points in nautical miles = 30

length of a cell side in nautical miles = 3

time step in hours = .33

maximum number of time steps = 17

track length in nautical miles = .50

delta in nautical miles = 5

leg length distribution index = 3

random number generator = standard

random number seed = 7351

number of tracks completed = 10000

number of tracks terminated = 0

call entry sum = 9999.999

cell entries are rounded integer
RANTRAC.BAS static diffusion probability map

number of diffusions = 14

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submarine speed in knots = 10
distance between end points in nautical miles = 30
length of a cell side in nautical miles = 3
time step in hours = .3
maximum number of time steps = 17
track length in nautical miles = 50
delta in nautical miles = 5
leg length distribution index = 3
random number generator = standard
random number seed = 7351
number of tracks completed = 10000
number of tracks terminated = 0
cell entry sum = 10000
cell entries are rounded integer

68
Number of diffusions = 15

Submarine speed in knots = 10
Distance between end points in nautical miles = 30
Length of a cell side in nautical miles = 3
Time step in hours = .3
Maximum number of time steps = 17
Track length in nautical miles = 50
Delta in nautical miles = 5
Leg length distribution index = 3
Random number generator = standard
Random number seed = 7351
Number of tracks completed = 10000
Number of tracks terminated = 0
Cell entry sum = 9999.999
Cell entries are rounded integer
RANTRACK.BAS: static diffusion probability map

<table>
<thead>
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<th>number of diffusions = 16</th>
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Submarine speed in knots = 10
Distance between endpoints in nautical miles = 30
Length of cell side in nautical miles = .3
Time step in hours = .3
Maximum number of steps = 17
Track length in nautical miles = 50
Delta in nautical miles = 5
Leg length distribution index = 3
Random number generator = standard
Random number seed = 7351
Number of tracks completed = 10000
Number of tracks terminated = 0
Cell entry sum = 100000
Cell entries are rounded integer
RANTRACK: BAS static diffusion probability map

number of diffusions = 17

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0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
```

submarine speed in knots = 10
distance between end points in nautical miles = 30
length of a cell side in nautical miles = 3
timestep in hours = .3
maximum number of time steps = 17
track length in nautical miles = 50
delta in nautical miles = 5
leg length distribution index = 3
random number generator = standard
random number seed = 7351
number of tracks completed = 10000
number of tracks terminated = 0
cell entry sum = 10000

cell entries are rounded integer
VI. The Analysis Program

The analysis program requires the following inputs: the speed of the submarine in knots; the distance between the end points in nautical miles; the track length in nautical miles; delta, the average distance between course changes (leg length) in nautical miles; the leg length distribution parameter, an integer that defines the gamma distribution that determines leg length (Inputing 1 gives an exponential distribution.) and the number of tracks to be generated. If an auxiliary pseudorandom number generator is not chosen, the option to supply a seed for the QuickBASIC random number generator is given. Next, the option to either view single tracks and terminate the program or to input the number of tracks to be generated to produce data of the kind presented above.

The program is written for a computer monitor with screen mode 12 capability. To change this requirement, the statement SCREEN 12 on Line 4780 must be changed. For example, for a monitor with CGA capability, it could be replaced by SCREEN 2.

To run the program under QuickBASIC, the /ah switch must be used to duplicate the program results in this report. This switch allows arrays of size greater than 64K. In addition, it may be necessary to have FILES = 8 and BUFFERS = 2 in the CONFIG.SYS file and to remove TSR file activation statements from the AUTOEXEC.BAT file.

The program code listed in Appendix 1 provides for the addition of an auxiliary random number generator as an alternative to the QuickBASIC generator through Lines 200, 210 and 220. These
lines allow auxiliary generator setup code in a subroutine starting at Line 7720 and generator code in a subroutine starting at Line 7810. This line number was chosen to accommodate code that is based on a Generalized Feedback Shift Register (GFSR) pseudorandom number generator that is listed in Reference 3. If an auxiliary generator will not be added, Lines 200, 210 and 220 can be removed.
Appendix 1. The Analysis Program Listing

10 HS = "RA NT RACK .BAS": REM a program to analyze some random track generation procedures
20 CLS : DEFINT I-N.
30 PI = 4 * ATN(1): NTR = 0: RS = "standard": FLAG3 = 0: FLAG4 = 0: FLAG5 = 0
40 PRINT : INPUT "submarine speed in knots"; V
50 PRINT : INPUT "distance between the end points in nautical miles"; D
60 PRINT : INPUT "track length in nautical miles"; TL
70 IF TL < D THEN 60.
80 DM = SQRT(TL * TL - D * D) / 2: REM maximum distance from the X-axis
90 SL = DM / 7: IF D / 2 > SL THEN SL = (D / 2) / INT(D / 2 / SL): REM length of a cell side
100 TS = SL / V: REM time step in hours
110 MNS = 30: REM maximum number of steps
120 HS = CINT(TL / SL): REM number of time steps in the track
130 IF HS > MNS THEN GOTO 60
140 SF = (64 / 35) * DS / 1000: REM screen factor
150 AS = "cell dimension = " + STR$(SL) + " nm": BS = "time step = " + STR$(TS) + " hr"
160 PRINT : PRINT AS: PRINT : PRINT BS
170 PRINT : INPUT "delta in nautical miles";
DEL: REM maximum average leg length in nautical miles
180 IF DEL < TL * TL / (TL - D) / 50 THEN 170
190 PRINT : INPUT "leg length distribution index";
M1
200 AS = "=": PRINT : INPUT "standard or auxiliary random number generator (s/a)";
A$ 210 IF AS = "A" OR AS = "a" THEN GOSUB 7720: GOTO 280
220 IF AS = "S" OR AS = "s" THEN 230 ELSE 200
230 AS = "=": PRINT : INPUT "a random number seed (y/n)";
A$ 240 IF AS = "N" OR AS = "n" THEN 280
250 IF AS = "Y" OR AS = "y" THEN FLAG4 = 1 ELSE 230
260 PRINT : INPUT "random seed": RNS
270 IF RNS < -32768 OR RNS > 32767 THEN 260 ELSE RANDOMIZE RNS
280 AS = "=": PRINT : INPUT "view only single tracks (y/n)";
A$ 290 IF AS = "Y" OR AS = "y" THEN FLAG5 = 1: NT = 1: GOTO 320
300 IF AS = "N" OR AS = "n" THEN 310 ELSE 280
310 PRINT : INPUT "number of tracks";
NT 320 AO = TL / 2: REM semia major axis of the initial focusing ellipse
330 CD = D / 2: REM distance from the center to a focus of the initial focusing ellipse
340 MNL = 30
360 REDIM MP(-LL TO LU, -ML TO MU, MNS)
370 REDIM MT(-1 TO 1, -1 TO 1, -ML TO MU, -ML TO MU)
380 REDIM MTs(-1 TO 1, -1 TO 1, -LL TO LU, -ML TO MU)
390 FOR J = 1 TO NT
400 REDIM X(MNL + 1), Y(MNL + 1), XS(MNL + 1), YS(MNL + 1), F(C(MNL + 1), T(MNL + 1), TLEG(MNL + 1)
410 X(o) = 0: Y(o) = 0: REM coordinates of the initial point for all tracks
420 FR(o) = 0: TLEG(o) = 0
430 FLAG1 = 0
440 A = AO: C = CO: S = 0
450 GOSUB 4770
460 FOR I = 1 TO MNL: REM leg number
470 B1 = SQRT((TL + D) / (TL - D))
480 B2 = SQRT(1 - D * D / TL / TL)
490 GOSUB 7700
500 ON ERROR GOTO 510: GOTO 520
510 RESUME 490
520 FLAG2 = 0
530 IF RAND <= .5 THEN 550
540 RAND = RAND - .5: FLAG2 = 1
550 RC = 2 * ATN(B2 * TAN(P1 * RAND - ATN(B1)) + D / TL): REM course in radians relative to the minor axis of the focusing ellipse
560 ON ERROR GOTO 0
570 IF FLAG2 = 1 THEN RC = PI - RC
580 AL = (TL - D) / (TL - D * SIN(RC)): REM average leg length for the relative course RC
590 GOSUB 7620
600 ON ERROR GOTO 0
610 FR(I) = RC + S: REM course in radians on leg I
620 TLEG = (A * A - C * C) / (A - C * SIN(RC)): REM maximum leg length in nautical miles for the relative course RC
630 IF TLEG >= TLEG THEN TLEG = TLEG: FLAG1 = 1: REM track is terminated at the final point
74
640: GOSUB 6030
650: LINE (X(I), Y(I)) - (X(I - 1), Y(I - 1))
660: IF I > 0 THEN 1170
670: C = A: REM remaining track length in nautical miles
680: S = BR - PI / 2: REM direction of the minor axis of the focusing ellipse
690: TLEG(I) = TLEG(I) - length of leg I
700: IF FLAG1 = 1 THEN 750
710: NEXT I
720: NTR = NTR + 1
730: J = J + 1
740: GOTO 1280: REM track terminated
750: LINE (D / 2, 0) - (X(I), Y(I))
760: NLEG = I + 1: REM number of legs
770: TLEG = 2 * C: TLEG(NLEG) = TLEG
780: H = S * PI / 2: REM bearing in radians of final point from the start of the track
790: FR(NLEG) = H: REM course in radians of last leg
800: X(NLEG) = D / 2: REM x-coordinate of final point for all tracks
810: Y(NLEG) = 0: REM y-coordinate of final point for all tracks
820: T(0) = 0
830: FOR I = 1 TO NLEG
840: T(I) = TLEG(I) / V: REM time in hours to traverse leg I
850: T(I) = T(I - 1) + T: REM time in hours from the initial point to the end point of leg I
860: NEXT I
870: XS(0) = -D / 2: YS(0) = 0
880: K = 1: TSK = TS
890: FOR I = 1 TO NLEG
900: IF TSK > T(I) AND I < NLEG THEN 960: REM the next time step point is past the Ith leg
910: T(I) = TSK - T(I - 1): REM time from the starting point of the Ith leg to the Kth time step point
920: XS(K) = X(I - 1) + V * T(I) * SIN(FR(I)); REM x-coordinate of the Kth time step point
930: YS(K) = Y(I - 1) + V * T(I) * COS(FR(I)); REM y-coordinate of the Kth time step point
940: K = K + 1: TSK = TSK + TS: REM next time step
950: IF K > NS THEN 980 ELSE 900
960: NEXT I
970: ERASE X, Y, FR, T, TLEG
980: FOR K = 1 TO NS
990: CIRCLE (XS(K), YS(K)), 8 * SF
1000: NEXT K
1010: IF FLAGS = 0 THEN 1050
1020: AS = "": INPUT "Quit (y/n)?"; AS
1030: IF AS = "Y" OR AS = "y" THEN CLS: GOTO 400
1040: IF AS = "N" OR AS = "n" THEN END ELSE 1020
1050: FOR I = 0 TO NS
1060: FOR L = 0 TO LU
1070: IF (L + 1 / 2) * SL < XS(I) AND XS(I) <= (L + 1 / 2) * SL THEN 1090: REM the x-coordinate of the Ith time step point is in range L
1080: NEXT L
1090: NEXT I
1100: IF (M + 1 / 2) * SL < YS(I) AND YS(I) <= (M + 1 / 2) * SL THEN 1130: REM the y-coordinate of the Ith time step point is in range M
1110: NEXT M
1120: GOTO 1270
1130: MP(L, M, I) = MP(L, M, I) + 1: REM random tour probability map element
1140: IF I > 1 THEN 1170
1150: LO = L: MO = M
1160: GOTO 1270
1170: L1 = L: M1 = M
1180: FOR W = -1 TO 1
1190: FOR K = -1 TO 1
1200: IF NOT (L1 = LO + W AND M1 = MO + K) THEN 1240
1210: MTS(N, K, LO, MO, I - 1) = MTS(N, K, LO, MO, I - 1) + 1: REM dynamic diffusion matrix element
1220: MTS(N, K, LO, MO) = MTS(N, K, LO, MO) + 1: REM static diffusion matrix element
1230: GOTO 1260
1240: NEXT K
1250: NEXT W
1260: LO = L1: MO = M1
1270: NEXT I
1280: NEXT J
1290: AS = "Y": PRINT: INPUT "display a random tour probability map (y/n)?"; AS
1300: IF AS = "Y" OR AS = "n" THEN 1500

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1310 IF A$ = "y" OR A$ = "Y" THEN 1320 ELSE 1290
1320 SCREEN 0:CLS
1330 PRINT "NS = "; NS
1340 PRINT: INPUT "enter the number of time steps from 0 to NS "; I
1350 IF I < 0 OR I > NS THEN 1340
1360 FOR N = 10 TO -10 STEP -1
1370 XS = STR$(N*9,I,I):XS=LTRIM$(RTRIM$(XS)):PRINT XS:TAB(5)
1380 FOR N = -8 TO 8
1390 XS = STR$(N*9,M,I):XS=LTRIM$(RTRIM$(XS)):PRINT XS:TAB((N + 9) * 4 + 5):
1400 NEXT N
1410 XS = STR$(N*9,M,I):XS=LTRIM$(RTRIM$(XS)):PRINT XS
1420 NEXT M
1430 IF A$ = "n" OR A$ = "N" THEN 1290
1440 IF A$ = "n" OR A$ = "N" THEN 1290
1450 IF A$ = "y" OR A$ = "Y" THEN 1460 ELSE 1430
1460 WIDTH LPRINT 130
1470 GOSUB 4880
1480 WIDTH LPRINT 80
1490 GOTO 1290
1500 IF A$ = "n" OR A$ = "N" THEN 1510
1510 IF A$ = "n" OR A$ = "N" THEN 1520
1520 IF A$ = "y" OR A$ = "Y" THEN 1530 ELSE 1500
1530 SCREEN 0:CLS
1540 PRINT "NS = "; NS
1550 PRINT: INPUT "enter the number of time steps from 0 to NS "; I
1560 IF I < 0 OR I > NS THEN 1550
1570 WIDTH LPRINT 130
1580 GOSUB 4880
1590 WIDTH LPRINT 80
1600 GOTO 1290
1610 IF A$ = "n" OR A$ = "N" THEN 1620
1620 IF A$ = "n" OR A$ = "N" THEN 1630
1630 IF A$ = "y" OR A$ = "Y" THEN 1640 ELSE 1610
1640 WIDTH LPRINT 130
1650 FOR I = 0 TO NS
1660 GOSUB 4880
1670 NEXT I
1680 IF A$ = "n" OR A$ = "N" THEN 1690
1690 IF A$ = "n" OR A$ = "N" THEN 1700
1700 IF A$ = "y" OR A$ = "Y" THEN 1710 ELSE 1680
1710 PRINT: INPUT "input the data file name "; FS
1720 ON ERROR GOTO 1750:GOTO 1740
1730 RESUME 1710
1740 OPEN ""#", 1, FS
1750 FOR I = 0 TO NS
1760 GOSUB 7050
1770 NEXT I
1780 CLOSE #1
1790 ON ERROR GOTO 0
1800 ERASE MP
1810 IF A$ = "n" OR A$ = "N" THEN 1820
1820 IF A$ = "n" OR A$ = "N" THEN 1830
1830 IF A$ = "y" OR A$ = "Y" THEN 1840 ELSE 1800
1840 SCREEN 0:CLS:GOSUB 6480
1850 PRINT:PRINT
1860 FOR K = 1 TO -1 STEP -1
1870 PRINT:PRINT MT(-1, K, L, M, I - 1);TAB(15);MT(0, K, L, M, I - 1);TAB(29);MT(1, K, L, M, I - 1)
1880 NEXT K
1890 PRINT:PRINT:PRINT:PRINT "number of tracks completed = "; NT
1900 PRINT:PRINT "number of tracks terminated = "; NTR
1910 PRINT:GOTO 1810
1920 IF A$ = "n" OR A$ = "N" THEN 1930
1930 IF A$ = "n" OR A$ = "N" THEN 1950 ELSE 1920
1940 IF A$ = "y" OR A$ = "Y" THEN 1950 ELSE 1920
1950 SCREEN 0:CLS:GOSUB 6480
1960 IF A$ = "n" THEN 1970 ELSE LPRINT A$
1970 LPRINT: LPRINT "transition number = "; I
1980 LPRINT: LPRINT "K = "; K
1990 LPRINT "y = "; M

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2000 FOR K = 1 TO -1 STEP -1
2010 FOR L = -1 TO N
2020 NEXT K
2030 NEXT L
2040 GOSUB 6130
2050 IF FLAG4 = 0 THEN N = 34 ELSE N = 33
2060 FOR I = 1 TO N
2070 LPRINT
2080 NEXT I
2090 GOTO 2120
2100 AS$ = "": PRINT : INPUT "nonzero dynamic transition matrices (y/n)": AS$ = "": PRINT : INPUT "nonzero dynamic transition matrices": LPRINT AS$
2110 LPRINT : LPRINT "transition number = "; I: LPRINT
2120 FOR L = (LL - 1) TO (LU - 1)
2130 FOR N = (ML - 1) TO (MU - 1)
2140 MAT = 0
2150 FOR K = 1 TO -1 STEP -1
2160 FOR L = -1 TO 1
2170 FOR N = -1 TO 1
2180 MAT = MT(N, K, L, M, I - 1) + MAT
2190 NEXT K
2200 NEXT L
2210 NEXT N
2220 IF MAT = 0 THEN 2340
2230 LPRINT : LPRINT "transition number = "; I: LPRINT
2240 NEXT K
2250 NEXT L
2260 LPRINT : LPRINT
2270 NEXT M
2280 NEXT N
2290 GOSUB 6130
2300 GOTO 2100
2310 AS$ = "": PRINT : INPUT "transition number = "; I
2320 PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; PRINT ; 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2660 SCREEN 0: CLS
2670 PRINT "NS = " NS
2680 PRINT : INPUT "enter the number of diffusions from 1 to NS"; ND
2690 IF ND < 1 OR ND > NS THEN 2680
2700 PRINT : INPUT "enter the number of tracks"; NT
2710 CLS
2720 GOSUB 4770
2730 FOR I = 1 TO NT
2740 GOSUB 5050
2750 NEXT J
2760 GOTO 2630
2770 AS = "N": PRINT : INPUT "generate a dynamic diffusion probability map (y/n)"; AS
2780 IF AS = "Y" OR AS = "y" THEN 2800
2790 IF AS = "N" OR AS = "n" THEN 3050 ELSE 2770
2800 SCREEN 0: CLS
2810 PRINT "NS = " NS
2820 PRINT : INPUT "enter the number of diffusions from 0 to NS"; ND
2830 IF ND < 0 OR ND > NS THEN 2820
2840 REDIM MPD(-LL TO LU, -ML TO MU) AS INTEGER
2850 GOSUB 5330
2860 AS = "N": PRINT : INPUT "display the dynamic diffusion probability map (y/n)"; AS
2870 IF AS = "Y" OR AS = "y" THEN 2890 ELSE 2860
2880 SCREEN 0: CLS
2890 FOR N = 10 TO -10 STEP -1
2900 XS = STR$(MPD(-9, N)): XS = LTRIMS(RTRIMS(XS)): PRINT XS; TAB(5)
2910 NEXT N
2920 NEXT N
2930 IF AS = "N" OR AS = "n" THEN 2770
2940, 2950 REDIM MPD(-LL TO LU, -ML TO MU) AS INTEGER
2960 GOSUB 5680
2970 NEXT ND
2980 AS = "N": PRINT : INPUT "print all the dynamic diffusion probability maps (y/n)"; AS
2990 IF AS = "Y" OR AS = "y" THEN 3080 ELSE 2970
3000 IF AS = "N" OR AS = "n" THEN 3160
3010 GOSUB 5680
3020 IF ND = 0 TO NS
3030 REDIM MPD(-LL TO LU, -ML TO MU) AS INTEGER
3040 CLS
3050 INPUT "input the data file name"; FS
3060 ON ERROR GOTO 3190
3070 FS = OPEN RO, 1, Fs
3080 IF FS THEN 3090
3090 CLOSE #1
3100 REDIM MPD(-LL TO LU, -ML TO MU) AS INTEGER
3110 GOSUB 5330
3120 GOSUB 5680
3130 NEXT ND
3140 ERASE MPD
3150 GOTO 2770
3160 AS = "N": PRINT : INPUT "print all the dynamic diffusion probability maps to a file (y/n)"; AS
3170 IF AS = "Y" OR AS = "y" THEN 3190
3180 IF ND = 0 TO NS
3190 PRINT : INPUT "input the data file name"; FS
3200 ON ERROR GOTO 3320
3210 GOTO 3230
3220 ON ERROR GOTO 0
3230 :OPEN "OH", #1, FS
3240 FOR ND = 0 TO NS
3250 REDIM MPD(-LL TO LU, -ML TO MU) AS INTEGER
3260 uGOSUB 5330
3270 GOSUB 6700
3280 NEXT ND
3290 CLOSE #1
3300 ON ERROR GOTO 0
3310 AS = "N": PRINT : INPUT "display a static transition matrix (y/n)"; AS
3320 IF AS = "Y" OR AS = "y" THEN 3350
3330 IF AS = "N" OR AS = "n" THEN 3430
3340 IF AS = "Y" OR AS = "y" THEN 3350 ELSE 3320

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3350 SCREEN 0: CLS: GOSUB 6510.
3360 PRINT: PRINT.
3370 FOR K = 1 TO -1 STEP -1
3380 PRINT: PRINT MTS(-1, K, L, M); TAB(15); MTS(0, K, L, M); TAB(29); MTS(1, K, L, M)
3390 NEXT K
3400 PRINT: PRINT: PRINT "number of tracks completed = "; NT
3410 PRINT: PRINT "number of tracks terminated = "; NTR
3420 PRINT: GOTO 3320
3430 IF AS = "N" THEN...
4040 NEXT K
4050 CLOSE #1.
4060 ON ERROR GOTO 0
4070 GOTO 8850
4080 AS = "R": PRINT : INPUT "generate static diffusion tracks (y/n)": AS
4090 IF AS = "Y" OR AS = "y" THEN 4100
4100 IF AS = "N" OR AS = "n" THEN 4230 ELSE 4080
4110 SCREEN 0: CLS
4120 PRINT "NS = ", NS
4130 PRINT : INPUT "enter the number of diffusions from 1 to NS": ND
4140 IF ND < 1 OR ND > NS THEN 4130
4150 PRINT : INPUT "enter the number of tracks": NT
4160 CLS
4170 GOSUB 4770
4180 FLAG3 = 1
4190 FOR J = 1 TO NT
4200 GOSUB 5050
4210 NEXT J
4220 GOTO 4080
4230 AS = "R": PRINT : INPUT "generate a static diffusion probability map (y/n)": AS
4240 IF AS = "Y" OR AS = "y" THEN 4260
4250 IF AS = "N" OR AS = "n" THEN 4520 ELSE 4230.
4260 SCREEN 0: CLS
4270 PRINT "NS = "; NS
4280 PRINT : INPUT "enter the number of diffusions from 0 to NS": ND
4290 IF ND < 0 OR ND > NS THEN 4280
4300 REDIM PDT(-LL TO LU, -ML TO MU)
4310 GOSUB 7220
4320 GOSUB 7550
4330 AS = "R": PRINT : INPUT "display the static diffusion probability map (y/n)": AS
4340 IF AS = "Y" OR AS = "y" THEN 4440
4350 IF AS = "N" OR AS = "n" THEN 4360 ELSE 4330
4360 SCREEN 0: CLS
4370 FOR N = 10 TO -10 STEP -1
4380 X$ = STR$(CINT(PDT(9, M))): X$ = LTRIM$(RTRIM$(X$)): PRINT X$; TAB(5);...
4730 GOSUB 6870
4740 NEXT ND
4750 ERASE PDT.
4760 END
4770 XM = 10 * SL: YM = 8 * SL
4780 SCREEN 12
4790 WINDOW (-XM, -YM)-(XM, YM).
4800 CIRCLE (-D / 2, 0), 10 * SF: CIRCLE (D / 2, 0), 10 * SF
4810 FOR M = 0 TO 19
4820 LINE (-XM + (M + 1 / 2) * SL, YM - SL / 2); (-XM + (M + 1 / 2) * SL, -YM + SL / 2)
4830 NEXT M
4840 FOR M = 0 TO 15
4850 LINE (-XM + SL / 2, YM - (M + 1 / 2) * SL); (-XM + SL / 2, YM - (M + 1 / 2) * SL)
4860 NEXT M
4870 RETURN
4880 AS$ = "$ PLUS "$ random tour probability map": LPRINT AS$
4890 LPRINT "number of time steps = "; I: LPRINT
4900 FOR M = 10 TO -10 STEP -1
4910 X$ = STR$(MP(-9, M, I)): X$ = LTRIM$(RTRIMS(X$)): LPRINT X$: TAB(MT); 
4920 FOR N = -8 TO 8
4930 X$ = STR$(MP(N, M, I)): X$ = LTRIM$(RTRIMS(X$)): LPRINT X$: TAB((N + 9) * (MT - 1) + MT);
4940 NEXT N
4950 X$ = STR$(MP(9, M, I)): LPRINT X$
4960 NEXT M
4970 GOSUB 6130
4980 GOSUB 6270
4990 LPRINT "cell entry sum = "; SM
5000 IF FLAG4 = 0 THEN N = 22 ELSE N = 21
5010 FOR K = 1 TO N
5020 LPRINT
5030 NEXT K
5040 RETURN
5050 LO = D / 2 / SL: MO = 0: REM initial cell indices
5060 FOR I = 1 TO ND
5070. REDIM MTA(-1 TO 1, -1 TO 1) AS INTEGER
5080 MPSUM = 0
5090 FOR N = -1 TO 1
5100 FOR K = -1 TO 1
5110 IF FLAG3 = 0 THEN 5130
5120 MPSUM = MTS(N, K, LO, MO) + MPSUM: GOTO 5140
5130 MPSUM = MT(N, K, LO, MO, I - 1) + MPSUM
5140 MTA(N, K) = MPSUM
5150 NEXT K
5160 NEXT N
5170 GOSUB 7700
5180 RNU = RND * MPSUM
5190 FOR N = -1 TO 1
5200 FOR K = -1 TO 1
5210 IF RNU < MTA(N, K) THEN 5260: REM transition from (LO+M,MO+K) to (LO,MO)
5220 NEXT K
5230 NEXT N
5240 ERASE MTA
5250 GOTO 5320
5260 L1 = LO + N: M1 = MO + K
5270 LINE (L1 + SL, M1 + SL); (LO + SL, MO + SL)
5280 CIRCLE (L1 + SL, M1 + SL), 8 * SF
5290 LO = L1: MO = M1
5300 ERASE MTA
5310 NEXT I
5320 RETURN
5330 REDIM MSUM(-LL TO LU, -ML TO MU, MWS)
5340 FOR I = 0 TO MS - 1
5350 FOR L = -LL TO LU
5360 FOR M = -ML TO MU
5370 FOR N = -1 TO 1
5380 FOR K = -1 TO 1
5390 MSUM(L, M, I) = M1(N, K, L, M, I) + MSUM(L, M, I)
5400 NEXT K
5410 NEXT N

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FOR M = 1 TO ND
5400 FOR I = 1 TO ND
5410 FOR K = 1 TO K
5420 IF NS(I, M) = 0 THEN NS(I, M) = 1
5430 NEXT K
5440 NEXT I
5450 NEXT M
5460 RETURN
5470 A$ = A$ + "dynamic diffusion probability map: LPRINT A$"
5480 LPRINT : LPRINT "number of diffusions = "; ND: LPRINT
5490 FOR M = 10 TO -10 STEP -1
5500 LS = STR$(MPD(M-9, M))$: XS = LTRIMS(RTRIMS(X$)): LPRINT XS; TAB(N);"
5100: IF ABS(Y / RF) > 1 THEN BR = PI / 2 * (1 - SGN(Y)) ELSE BR = PI / 2 - ATN(Y / RF / SQR(1 - Y * Y / RF / RF))
5110: IF BB < 0 THEN BR = 2 * PI - BR; REM bearing in radians of the final point from the end point of leg I.
5120: RETURN
5130: LPRINT: LPRINT "submarine speed in knots = "; V
5140: LPRINT "distance between end points in nautical miles = "; D
5150: LPRINT "length of a cell side in nautical miles = "; SL
5160: LPRINT "maximum number of time-steps = "; NS
5170: LPRINT "track length in nautical miles = "; TL
5180: LPRINT "delta in nautical miles = "; DEL
5190: LPRINT "leg length distribution index = "; NI
5200: LPRINT "random number generator = "; R$;
5210: IF FLAG4 = 0 THEN 6240
5220: LPRINT "random number seed = "; RNS
5230: LPRINT "number of tracks completed = "; NT
5240: LPRINT "number of tracks terminated = "; NTR
5250: RETURN
5260: FOR L = -LL TO LU
5270: SM = 0
5280: FOR L = -ML TO MU
5290: SM = MP(L, M, I) + SM
5300: NEXT M
5310: NEXT L
5320: RETURN
5330: FOR M = -ML TO MU
5340: SM = 0
5350: FOR L = -LL TO LU
5360: FOR M = -ML TO MU
5370: SM = MP(L, M, I) + SM
5380: NEXT M
5390: NEXT L
5400: RETURN
5410: PRINT "NS = "; NS
5420: PRINT : INPUT "enter the transition number from 1 to NS"; I
5430: IF I < 1 OR I > NS THEN 6490
5440: PRINT : INPUT "x-coordinate"; L
5450: IF L < -(LL - 1) OR L > (LU - 1) THEN 6510
5460: PRINT : INPUT "y-coordinate"; M
5470: IF M < -(ML - 1) OR M > (MU - 1) THEN 6530
5480: RETURN
5490: PRINT #1, 1, "submarine speed in knots = "; V
5500: PRINT #1, 1, "distance between end points in nautical miles = "; D
5510: PRINT #1, 1, "length of a cell side in nautical miles = "; SL
5520: PRINT #1, 1, "time step in hours = "; TS
5530: PRINT #1, 1, "maximum number of time steps = "; NS
5540: PRINT #1, 1, "track length in nautical miles = "; TL
5550: PRINT #1, 1, "delta in nautical miles = "; DEL
5560: PRINT #1, 1, "leg length distribution index = "; NI
5570: PRINT #1, 1, "random number generator = "; R$
5580: IF FLAG4 = 0 THEN 6670
5590: PRINT #1, 1, "random number seed = "; RNS
5600: PRINT #1, 1, "number of tracks completed = "; NT
5610: PRINT #1, 1, "number of tracks terminated = "; NTR
5620: RETURN
5630: AS = NS + " dynamic diffusion probability map": PRINT #1, AS
5640: PRINT #1, 1, "number of diffusions = "; ND: PRINT #1,
5650: FOR M = 10 TO -10 STEP -1
5660: X$ = STR$(MPD(-9, M)): X$ = LTRIM$(RTRIM$(X$)): PRINT #1, X$: TAB(MT);
5670: FOR N = -8 TO 8
5680: X$ = STR$(MPD(N, M)): X$ = LTRIM$(RTRIM$(X$)): PRINT #1, X$: TAB((N + 9) * (MT - 1) + MT)
5690: NEXT N
5700: X$ = STR$(MPD(9, M)): X$ = LTRIM$(RTRIM$(X$)): PRINT #1, X$
6780 NEXT M
6790 GOSUB 6560
6800 GOSUB 6340:
6810 PRINT #1, "cell entry sum = "; SM
6820 IF FLAG4 = 0 THEN N = 16 ELSE N = 15
6830 FOR K = 1 TO N
6840 PRINT #1, 
6850 NEXT K
6860 RETURN
6870 AS = "AS + " " static diffusion probability map": PRINT #1, AS
6880 PRINT #1, ": PRINT #1, "number of diffusions = "; ND: PRINT #1,
6890 FOR M = 10 TO -10 STEP -1
6900 XS = STR$(CINT(POT(-9, M))): XS = LTRIM$(RTRIM$(XS)): PRINT #1, XS; TAB(MT);
6910 FOR N = -8 TO 8
6920 XS = STR$(CINT(POT(N, M))): XS = LTRIM$(RTRIM$(XS)): PRINT #1, XS; TAB(N + 9) * (MT - 1) + MT;
6930 NEXT N
6940 XS = STR$(CINT(POT(9, M))): XS = LTRIM$(RTRIM$(XS)): PRINT #1, XS
6950 NEXT M
6960 GOSUB 6560
6970 GOSUB 6410
6980 PRINT #1, "cell entry sum = "; SM
6990 PRINT #1, "cell entries are rounded integer"
7000 IF FLAG4 = 0 THEN N = 16 ELSE N = 15
7010 FOR K = 1 TO N
7020 PRINT #1,
7030 NEXT K
7040 RETURN
7050 AS = "AS + " " random tour probability map": PRINT #1, AS
7060 PRINT #1, ": PRINT #1, "number of time steps = "; I: PRINT #1,
7070 FOR M = 10 TO -10 STEP -1
7080 XS = STR$(MP(-9, M, I)): XS = LTRIM$(RTRIM$(XS)): PRINT #1, XS; TAB(MT);
7090 FOR N = -8 TO 8
7100 XS = STR$(MP(N, M, I)): XS = LTRIM$(RTRIM$(XS)): PRINT #1, XS; TAB(N + 9) * (MT - 1) + MT;
7110 NEXT N
7120 XS = STR$(MP(9, M, I)): XS = LTRIM$(RTRIM$(XS)): PRINT #1, XS
7130 NEXT M
7140 GOSUB 6560
7150 GOSUB 6270
7160 PRINT #1, "cell entry sum = "; SM
7170 IF FLAG4 = 0 THEN N = 16 ELSE N = 15
7180 FOR K = 1 TO N
7190 PRINT #1,
7200 NEXT K
7210 RETURN
7220 REDIM MSUMS(-LL TO LU, -ML TO MU)
7230 FOR L = -LL TO LU
7240 FOR M = -ML TO MU
7250 FOR N = -1 TO 1
7260 FOR K = -1 TO 1
7270 MSUMS(L, M) = MTS(N, K, L, M) + MSUMS(L, M)
7280 NEXT K
7290 NEXT N
7300 NEXT M
7310 NEXT L
7320 PDT(-D / 2 / SL, 0) = WT: REM initial cell probability factor
7330 IF ND = 0 THEN RETURN
7340 FOR I = 1 TO ND
7350 REDIM B(-LL TO LU, -ML TO MU)
7360 FOR L = -(LL - 1) TO (LU - 1)
7370 FOR M = -(ML - 1) TO (MU - 1)
7380 FOR N = -1 TO 1
7390 FOR K = -1 TO 1
7400 IF MSUMS(L - N, M - K) = 0 THEN 7420
7410 B(L, M) = MTS(K, L - N, M - K) / MSUMS(L - N, M - K) * PDT(L - N, M - K) + B(L, M)
7420 NEXT K
7430 NEXT M
7440 NEXT L
7450 NEXT M
7460 FOR L = -LL TO LU
7470 NEXT L
7480 RETURN
7470 FOR M = ML TO MU.
7480 POT(L, M) = B(L, M); REM static diffusion probability map element
7490 NEXT M
7500 NEXT L
7510 ERASE = 0
7520 NEXT I
7530 ERASE NSLMS
7540 RETURN
7550 SM = 0
7560 FOR L = LL TO LU
7570 FOR M = ML TO MU.
7580 SM = SM + POT(L, M)
7590 NEXT M
7600 NEXT L
7610 RETURN
7620 TLEG = 0
7630 FOR L = 1 TO NI
7640 GOSUB 7700:
7650 ON ERROR GOTO 7660: GOTO 7670
7660 RESUME 7640.
7670 TLEG = TLEG + AL * LOG(1 - RAND) / NI + TLEG; REM trial leg length generator for the relative course RC
7680 NEXT L
7690 RETURN
7700 IF R$ = "standard" THEN RAND = RND ELSE GOSUB 7810; REM auxiliary random number generator subroutine branch
7710 RETURN
7720 R$ = "auxiliary"; REM the first line of an auxiliary random number generator setup subroutine
References


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Center for Naval Analysis
4401 Ford Avenue
P. O. Box 16268
Alexandria, VA 22302-0268

Director, Wargaming Department
Naval War College
Attn: Code 3314B and Code 33T
Newport, RI 02841

Naval Postgraduate School
Monterey, CA 93943-5000
Attn: Code OR/Fo and Code AW