

## Introduction

America is highly urbanized and the vast majority of its population resides in metropolitan centers. Residential segregation is a fundamental fact of social life in these areas. It structures daily life and patterns of social interaction in innumerable ways. It has major consequences for the life chances of individuals and groups living in different social areas and neighborhoods within American urban areas.

An extensive research literature documents the patterns of segregation in American cities and its trends over time (e.g., Taeuber and Taeuber 1965; Lieberman 1980; Massey and Denton 1993). This literature uses summary indices that quantify different dimensions of segregation. It is known for refined conceptualization and careful systematic description of segregation patterns. Another important literature focuses on the causes of segregation. This literature draws on a variety of methodologies and analytic strategies. A partial listing of these includes city-level modeling of segregation patterns (e.g., Frey and Farley 1993; Massey and Denton 1987), quasi-experimental audit studies of housing discrimination (e.g., Fix and Stryuck 1993), ethnographic studies of the micro-level processes underlying neighborhood segregation (e.g., DeSena 1994), analysis of individual spatial mobility (e.g., Alba and Logan 1993; South and Crowder 1997; 1998), and analytic studies of the compatibility of ethnic preferences and neighborhood integration (e.g., Clark 1993; Schelling 1971).

Unfortunately, the descriptive studies and the various threads of research on causes of segregation are rarely joined. City-level descriptions of segregation patterns are almost never linked to micro-level processes. Studies of micro-level segregation dynamics almost never attempt to assess the degree to which the dynamics in question contribute to observed macro-level patterns of segregation.

The SimSeg Lite program tries to bring the two literatures together by implementing a simulation model that has two key characteristics. The first is that it gives expression to theories of the micro-level processes and structural constraints that generate and shape segregation and sets them “in motion” in a virtual city. The second is that it registers the consequences of these dynamics for segregation by calculating and reporting standard city-level segregation indices *and* by presenting a continuously updated city “landscape” that provides an intuitive, graphical representation of segregation.

SimSeg Lite is offered as a tool students can use to explore questions about residential segregation. This document serves as a User’s Guide for the program. It introduces the program’s features and capabilities and provides an overview of how to use the program.

# **SimSeg Lite: User’s Guide and Program Documentation**

by

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## Description and Purpose of the Program

The SimSeg Lite program is an educational tool geared to helping students explore the social processes and conditions that contribute to the creation and maintenance of racial residential segregation in urban areas. SimSeg Lite allows users to explore prevailing theories of residential segregation by designing and running simulation experiments that implement processes and conditions emphasized by different theories. The results of the simulation experiments provide insights into questions about how different social dynamics and urban-demographic conditions may (or may not) affect residential segregation (at least in the context of the SimSeg Lite model).

The theory and research that serves as the inspiration for SimSeg Lite is often highly technical and abstract. One of the aims of the program is to help make the concepts, insights, and findings of this technical literature accessible to non-specialists. It tries to do this by permitting users to manipulate and explore models of segregation dynamics via an intuitive, easy-to-use model interface. Specifically, the program:

1. Provides a simplified model of segregation dynamics that incorporates key mechanisms emphasized in major theories;
2. Depicts segregation outcomes via graphical representations as well as quantitative index scores to give non-technical users an intuitive sense of various dimensions of segregation; and
3. Permits users to manipulate the basic parameters governing the model segregation dynamics via “point-and-click” selection boxes that make it very easy to configure and execute simulation experiments.

Another feature of the SimSeg Lite program is that it draws on the new technologies of the World Wide Web and web-based software.<sup>1</sup> Thus, this instructional tool is available to educators, students, and other interested parties who have access to the World Wide Web.

In sum, the program is offered with the hope that it can help provide students and interested lay persons a useful introduction to residential segregation via an intuitive, graphically oriented model that is faithful to the research literature but conveys theory and key findings in a manner that is accessible to students with little or no background in the technical literature on residential segregation.

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<sup>1</sup> Specifically, SimSeg Lite is a Java applet that is loaded from a web page and runs under Java-capable web browsers.

## Program Availability and Support

The SimSeg Lite program can be found on the web at the Virtual Laboratory in Racial and Ethnic Stratification and Inequality (VLAB-RESI), a site developed and supported with funding from the National Science Foundation and developed by Mark Fossett, Professor in the Department of Sociology and Research Affiliate at the Racial and Ethnic Studies Institutes at Texas A&M University, College Station, Texas. The web address for the site is:

<http://vlab-resi.tamu.edu>

Funding for the development of the SimSeg Lite program and the VLAB-RESI website has been provided by a grant from the **National Science Foundation** (Division of Undergraduate Education, Course Curriculum and Laboratory Improvement Program). Institutional support for the program and the website has been provided by the Department of Sociology and the Racial and the Ethnic Studies Institute at Texas A&M University, College Station, Texas.

## SimSeg – Big Brother to SimSeg Lite

SimSeg Lite is adapted from SimSeg – a more ambitious simulation model that is SimSeg Lite’s namesake and “big brother”. SimSeg is a more powerful and comprehensive standalone program that runs under Windows. It takes advantage of the greater resources available in that computing environment and implements a richer, more complex simulation model.

In addition, the SimSeg program also contains advanced features not found in SimSeg Lite. These features give the user more control over the simulation model, an ability to design and run more sophisticated simulation experiments, and an ability to explore the outcomes more systematically and in greater detail. For example, SimSeg presents a more detailed visual depiction of the evolution of the city landscape over the course of simulation experiments; it provides an extensive library of graphical results and the ability to save these images to disk; it provides the ability to design multi-stage simulation experiments; it provides the ability to save simulation “scenarios” for repeated use; it provides the ability to save and “replay” simulation results; it provides the ability to examine a much wider range of simulation results; it provides the ability to create much larger simulated cities; it provides the ability to run multiple simulations (included repeated trials of the same simulation) in “batch” mode; and it provides the ability to save output files suitable for analysis using stand-

ard statistical packages.

SimSeg is designed to be used in both research and education. It is more more difficult to use than SimSeg Lite, but it offers the advanced student many more options for exploring theory and examining running simulation experiments. For further information about the SimSeg program, visit the following address on the World Wide Web:

<http://vlab-resi.tamu.edu/simseg/simseg.htm>

## Overview of the SimSeg Lite Model

The SimSeg Lite program implements a simplified model of segregation dynamics. The model's simplicity is intentional and reflects its orientation to teaching and instruction. SimSeg Lite does not try to model segregation dynamics in their full complexity as this is not necessary or even desirable for the purposes of illustrating theoretical and substantive principles involved in residential segregation. It is guided by the philosophy that keeping the model simple helps make it easier for students to use the program and understand its substantive implications.

In keeping with this philosophy, the SimSeg Lite program also adopts a strategy of "hiding" the technical details of the model from the user. Instead of having the user study and focus on the algorithms and mathematical calculations involved in the technical implementation of the model, the program is designed to permit the user to manipulate the model through selection boxes that provide intuitive descriptions of the model's parameter settings. The descriptions (and associated discussions in help files) adequately convey the sense of how a given experiment is being configured in relation to major theories about the determinants of residential segregation.<sup>2</sup> These selection boxes are seen in Figure 1. They and the choices they present are discussed in more detail below.

**Representation of Segregation.** Also evident in Figure 1 are the two means by which the program presents segregation patterns. One is with traditional index scores; namely, the index of dissimilarity, the isolation index (i.e., the  $P^*$  index of co-ethnic contact), an index

<sup>2</sup> The details of the model are in fact available in technical documentation (available from the SimSeg Lite page of the VLAB-RESI website). But users do not need to acquaint themselves with these technical materials in order to use the model.

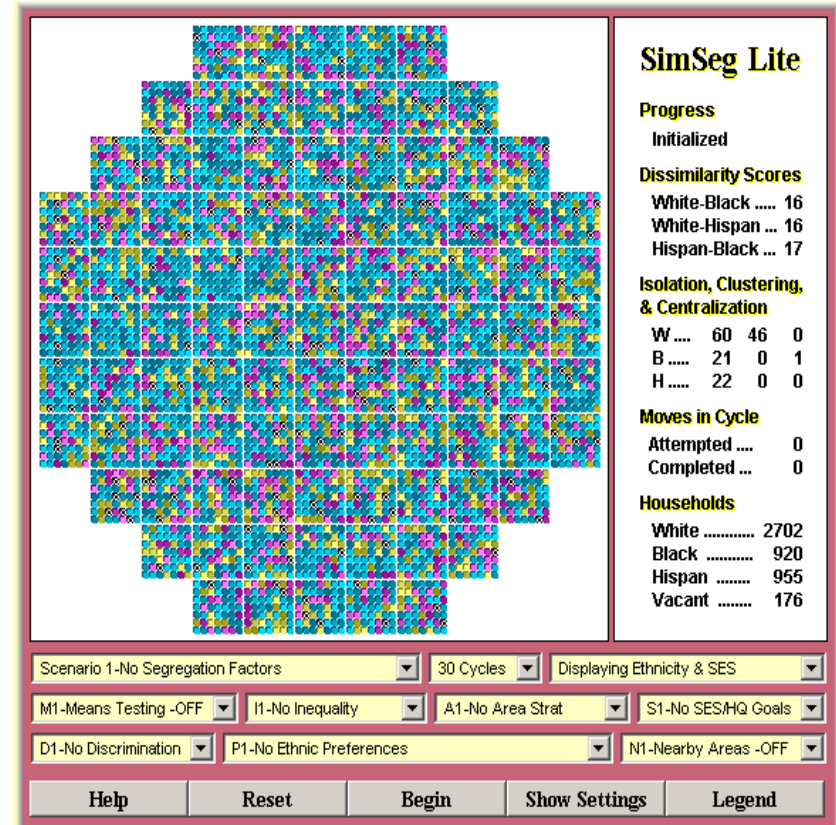


Figure 1

of clustering, and an index of centralization. The other is with a graphical representation of the "landscape" of the virtual city that depicts a grid of "bounded neighborhoods" populated by households whose ethnic and socioeconomic status are signified by color and shading according to the legend shown in Figure 2.

There are several benefits to this approach. One is that the model gives visual feedback as each simulation experiment unfolds. Since all simulations begin with a random distribution of households in space, the operation of segregation-promoting dynamics becomes evident as the landscape steadily "congeals" into a visually distinct pattern of segregation such as that seen in Figure 3.

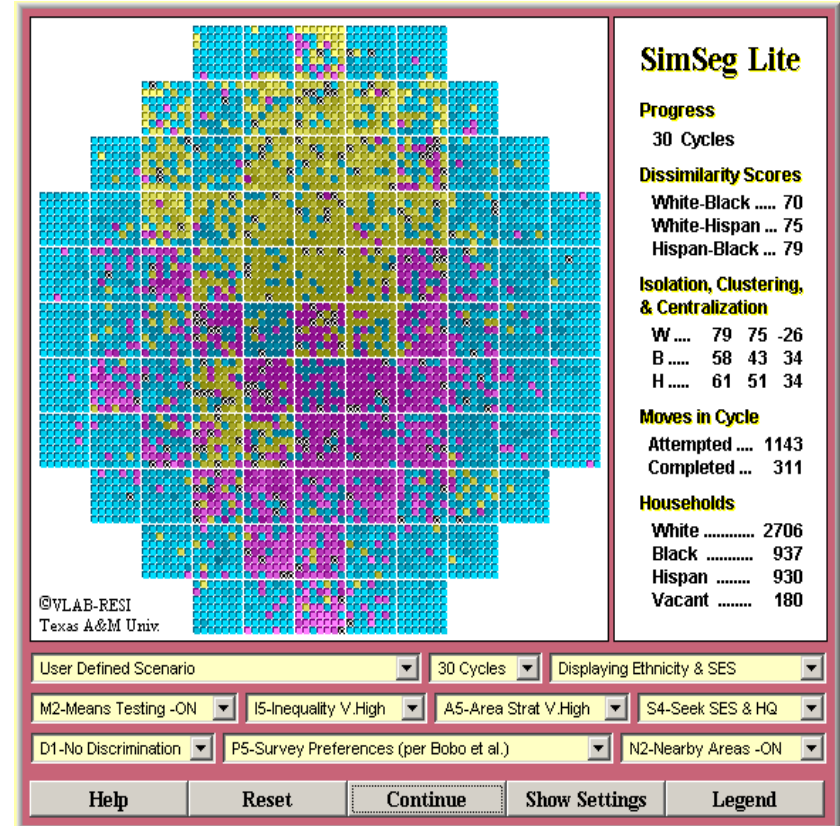


**Figure 2**

Another benefit is that the visual representation of the virtual city “landscape” and the numerical index scores are presented together. Furthermore, both are updated simultaneously as the simulation experiment unfolds. This helps those who are new to the study of segregation make a stronger, more intuitive connection between quantitative summary scores and specific patterns of segregation. Thus, for example, dissimilarity scores are higher in Figure 3, consistent with the distinct visual pattern of residential separation of groups. Similarly, the centralization scores are lower in Figure 1 because all groups are spread throughout the city.

In addition, the visual representation gives a clear sense of another pattern of segregation evident in Figure 3, namely clustering, for which there are really no widely recognized quantitative measures that are easy to explain to a non-technical audience.

**Housing System.** In the SimSeg Lite housing system, housing units are organized into bounded neighborhoods consisting of a 7x7 square area with 49 houses. There are 97 such neighborhoods and a total of 4,753 housing units. Each housing unit is assigned a value on a scale from 0-100. These values are most relevant to segregation when residential moves are “means tested”; that is, when households are required to be able to “afford” the housing units they move to.



**Figure 3**

Depending on model settings, higher-quality housing may be distributed evenly throughout the city or it may be concentrated in outlying neighborhoods. In this model, the location of housing is permanently fixed and the value of housing is also fixed.

**Population System.** The population consists of “households”. The construct is a simple one in this model. Households’ characteristics and behaviors reflect those of the household head who is assigned characteristics of ethnic status, socio-economic status, and residential preferences. Households always reside in housing units. There are approximately 5% fewer households than housing units. As a result, at any one time about 5% of housing units are vacant.

**Ethnic System.** Households are assigned one of three possible ethnic statuses: White, Black, or Hispanic. This status is fixed and cannot change. The population distribution of each group is approximately 60% White, 20% Black, and 20% Hispanic.

**Status System.** The distribution of socio-economic status for households is bell-shaped. The distribution of housing values follows this same distribution. Both are measured on a scale of 0-100. This value determines the “quality” of housing units and the “means” or purchasing power of households. A household’s status is fixed and cannot change. Depending on model settings. The status system may include varying degrees of status inequality between white and minority households.

**Preferences.** Preferences motivate households to evaluate their residential situation and possibly to take action (i.e., relocate) to improve it. The model allows for three basic preferences. Two are related to socio-economic outcomes: namely, housing quality and neighborhood status. When households are motivated to seek high-quality housing, they will, all else equal, seek to move to the highest-quality house they can “afford”. When households are motivated to seek high-status neighborhoods, they will, all else equal, seek to move to a neighborhood with the highest average housing quality. When active, these preferences are held by all households (i.e., they do not vary by race or socio-economic status) and are uniform in “strength”.

The third set of preferences is ethnic preferences. These involve two sub-preferences: a desired degree of residential contact with in-group members (i.e., co-ethnic contact) and a desired degree of residential contact with out-group members. Depending on model settings, these preferences may vary separately for Whites, Blacks, and Hispanics. Also depending on model settings, these preferences may be evaluated only with respect to the immediate bounded neighborhood, or it may also include “nearby” (i.e., adjacent) bounded neighborhoods. When active, ethnic preferences are “homogeneous”; that is, all members of a given group will hold identical ethnic preferences.<sup>3</sup>

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<sup>3</sup> This is one of many areas where the model implemented by the stand-alone SimSeg program is more complex and sophisticated. In SimSeg, the user can specify varying degrees of heterogeneity in ethnic preferences within ethnic groups including heterogeneity that varies systematically by socio-economic status. Interestingly, research conducted using the SimSeg program indicates that segregation is driven more by the central tendency of the ethnic preference distribution and only secondarily if at all by variation (heterogeneity) around the central tendency (Fossett 1999).

**Housing Search and Movement.** As a simulation experiment unfolds, households are selected at random and given the opportunity to “search” for new housing.<sup>4</sup> When a household engages in search, it evaluates its current residence (relative to whatever preferences are active) and compares it against a random selection of available (i.e., vacant) housing units. If the household finds a housing unit that it prefers over its present one, it will attempt to move to that unit. The move may or may not be successful depending on means testing and discrimination dynamics. If the household cannot move to its most preferred alternative, it will attempt to move to its next best alternative (if one exists).

In about 1 out of 5 occasions, households given the opportunity to search will be forced to move (assuming it is possible), even if they would prefer to stay in their current residence. This simulates job transfers, the formation of new households, major life-cycle transitions, and other events that precipitate household relocation.

**Time.** The model marks time in “cycles”. These are periods during which households are given the opportunity to engage in housing search and possible residential movement. The periods are calibrated roughly to generate the levels of household movement observed in “real” cities over a period of 6-12 months.

**Discrimination.** When minority households attempt to move, their efforts may be constrained by discrimination. In the model, discrimination is “exclusion” from predominantly white neighborhoods. The probability of encountering such exclusion is determined by three factors: the strength of the discrimination setting, the proportion white in the destination neighborhood, and the level of white “prejudice” (i.e., white’s preference for in-group contact).<sup>5</sup>

**Deterministic vs. Stochastic Outcomes.** The SimSeg Lite model is not deterministic in an absolute sense. Most processes in the model involve indeterminacy (implemented in the form of randomly selected events from an underlying probability distribution). Thus, the simulation never unfolds in exactly the same way twice and few micro-level outcomes are predictable with certainty. At the macro-

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<sup>4</sup> Households must move at least once, if they can, over the course of a simulation experiment. This requirement insures that their residential situation reflects model parameters, not the initial random assignment.

<sup>5</sup> This is another example of where the simulation model for the stand-alone SimSeg program is more complex and sophisticated. In addition to exclusion, its discrimination algorithms allow for ethnic “steering”, “redlining”, discrimination in qualifying for mortgages, and “tokenism” in exclusion patterns.

level some outcomes are unpredictable while others are tend to be fairly consistent across repeated experiments. One implication of this fact is that experiments must be repeated several times to determine if particular results are consistent or not.

The major features of the model have now been introduced. The next sections discuss how to invoke the program and use the model to conduct virtual “experiments”.

## Invoking the Program

To run the SimSeg Lite program, take the following steps.

1. Start your browser program (remember that it must be java enabled);
2. Point your browser to the home page of the VLAB-RESI website (<http://vlab-resi.tamu.edu/>);
3. Click on the “SimSeg Lite” link on the home page to load the web page dedicated to the SimSeg Lite program;
4. Click on the SimSeg Lite button on this page to start the SimSeg Lite program. It will open in a new browser window that is sized appropriately to display the program and associated help documents.

## On-Screen Program Organization

SimSeg Lite divides the browser window into four “frames”: a contact frame, a navigation frame, a notes frame, and a model frame.

The **Contact** frame is in the upper left. It provides links to return to the home page for the SimSeg Lite program and to e-mail comments about SimSeg Lite to the Webmaster for the VLAB-RESI web site..

The **Navigation** frame is in the middle left. It provides options for quitting the program, going forward and backward through screens, and invoking the help menu.

The **Notes** frame is in the lower left. It is reserved for presenting information about the SimSeg Lite displays. It also is where information about menu options and selections is presented.

The **Model** frame is on the right and takes up most of the window. The SimSeg Lite applet runs in this frame. It occupies most of the area in the frame and provides controls that allow the user to manipulate the SimSeg Lite model and display various graphical representations of segregation outcomes.

## SimSeg Lite Program Controls

The SimSeg Lite program is operated by using “controls” placed along the bottom of the program’s “frame”. The controls consist of three rows of “selection boxes” and a row of “buttons”. The selection boxes are used to manipulate the parameters of the SimSeg Lite model. The buttons are used for invoking the help system or for “resetting” and “initiating” simulation experiments.

### Program Selection Boxes

**Designed “Scenarios”.** A particular configuration of model settings is termed a “scenario”. Given the number of variables in the model and the number of settings each one may take, it is possible to specify literally thousands of different scenarios. The “Designed Scenarios” selection box provides a convenient means for selecting scenarios of particular interest.

The available designs reflect three central hypotheses offered to explain ethnic segregation: economic factors, discrimination, and ethnic preferences. Scenarios 1-8 allow for these to be made active in any combination ranging from none of the three (Scenario 1) to all of them (Scenario 8). A more detailed description of these scenarios is provided below, following the discussion of the possible settings for the variables in the model.

If any of the model’s seven variables are set by the user (rather than by using the “Designed Scenario” selection), the scenario is described as “User Defined”.

**Cycles per “Stage”.** Time in the simulation can be divided into “stages” a set of uninterrupted cycles that take place without changing the simulation “scenario”. The “Cycles” selection box provides the means for specifying how many cycles are in a “stage”. The possible settings are 1, 3, 5, 10, & 30. Choosing a higher setting allows the program to proceed toward a stable segregation pattern quickly. Choosing a lower setting allows the user to monitor intermediate outcomes more carefully. The default setting is 30 cycles.

**Display Options.** The “Display Options” selection box provides the means for choosing different graphical schemes to provide more easily view different aspects of the city landscape. The choices include: “Ethnicity Only” (a three-color scheme showing the ethnicity of households), “SES Only” (a graduated, monochrome scheme showing the socio-economic status of households), “Ethnicity & SES” (a three-color scheme with graduated shading that shows the ethnic and socio-economic status of households simultaneously), “Housing Val-

ues” (a graduated monochrome scheme that shows housing values), and “Distance Zones” (a scheme that uses shading to show four “concentric” zones with equal shares of housing units). The default setting is “Ethnicity and SES”.

**Means Test Moves.** The “Means Test Moves” selection box provides the means for specifying whether moves are means tested or not. If means testing is active (“ON”), households must be able to “afford” a housing unit before they can move into it.

**Inequality.** The “Inequality” selection box provides the means for specifying the degree of inequality between the distribution of socio-economic status for Whites and for Blacks and Hispanics. The possible choices for inequality are “none”, “low”, “medium”, “high”, and very high”. In the model, inequality is quantified using Lieberman’s index of net difference. The scores for the comparison of the White and combined minority (Black and Hispanic) status distribution under these settings are 0, 15, 30, 45, and 60.

**Area Stratification.** The “Area Stratification” selection box provides the means for specifying the degree to which high-quality housing is concentrated in outlying areas (i.e., distributed along a city-suburb gradient). The possible choices are “none”, “low”, “medium”, “high”, and very high”. In the model, area stratification is quantified by the percentage of variance in housing values explained by distance from the center of the city. The values of this statistic under these settings are 0, 20, 40, 60, and 80.

**Status & Housing Quality Preferences.** The “SES/HQ” selection box provides the means for specifying whether households will consider neighborhood status and housing quality when evaluating their residential situation. Either preference may be active or not. The four choices provide every possible combination of these settings. The default setting is for both to be “OFF” or inactive.

**Discrimination.** The “Discrimination” selection box provides the means for specifying whether minority households are subject to discrimination in the form of “exclusion” from predominantly white neighborhoods. That is, if they attempt to locate in the neighborhood, they are subject to being blocked from entering. The choices are “none”, “low”, “medium”, and “high”. Under these settings, minority households attempting to enter a 90% white neighborhood will be blocked 33%, 67%, and 95% of the time. The default setting is none.

**Ethnic Preferences.** The “Ethnic Preferences” selection box provides the means for specifying what configuration of ethnic preferences will be in effect. A total of 11 choices are provided. The associated in-group and out-group contact targets for each choice are enu-

Figure 4: Listing of Choices for Ethnic Preference Settings

Preference Choice	In-Group Contact Targets			Out-Group Contact Targets		
	W	B	H	W	B	H
1. No Ethnic Preferences	0	0	0	0	0	0
2. White Prejudice High	95	0	0	0	0	0
3. White Prejudice Medium	75	0	0	0	0	0
4. White Prejudice Low.	60	0	0	0	0	0
5. Survey Preferences	90	50	50	0	30	30
6. Weak Preferences A	60	20	20	0	0	0
7. Weak Preferences B	60	20	20	0	30	30
8. Weak Preferences C	60	20	20	0	60	60
9. Weak Preferences D	90	20	20	0	60	60
10. Minority Survey Prefs	0	50	50	0	30	30
11. Minority Weak Prefs	0	20	20	0	60	60
12. Strong Ethnic Solidarity	90	90	90	0	0	0

merated in Figure 4. References to “surveys” are to survey-based preference data reported in studies by Clark (1991), Bobo and Zubrinsky (1996), and Farley et al. (1978; 1994). The default setting is no active ethnic preferences.

**Nearby Areas.** The “Nearby Areas” selection box provides the means for specifying whether households will consider the ethnic mix in nearby (i.e., adjacent) areas in addition to the area that their residence (or potential alternative) is located. The default setting is “OFF” or “inactive”. However, this is relevant only when ethnic preferences are active.

### Program Buttons

**Help.** The “Help” button brings up a help menu in the “notes” frame on the left side of the screen. A second help button is also found in the navigation frame on the left side of the screen. It also can be used to invoke the help system.

**Reset.** The “Reset” button initializes a city landscape consistent with the simulation scenario established by the settings in the selection boxes. The user must click the “Reset” button before a simulation can be executed.

**Begin/Continue.** The “Begin” button becomes “active” when the city landscape has been “reset”. Clicking on the “Begin” button starts the simulation and causes it to proceed for the number of cycles specified in the “Cycles” selection box. After the cycles are completed, the button is relabelled “Continue”. Clicking on it will run the experi-

ment for another set of cycles.

**Show/Hide Settings.** The “Show Settings” button opens a window, which provides a text-based summary of the simulation scenario. The label for the button changes to “Hide Settings” and clicking on it will cause the window to close.

**Legend.** The “Legend” button causes the “legend” for the landscape to be displayed in the notes window.

## Neighborhood Zoom

There is one more significant program control. If you point to a neighborhood with your mouse and click on it, the program switches into “zoom” mode and shows the selected neighborhood and the immediate surrounding neighborhoods at 300% enlargement.

Clicking a second time returns the display to its normal view.

## Designed Scenarios Revisited

The seven selection boxes found on the second and third rows of selections boxes control the seven major variables governing the simulation model: means testing of housing moves, ethnic inequality in socioeconomic status, area stratification in housing value, preferences for high-status neighborhoods and high-quality housing, housing discrimination, ethnic preferences, and concern for nearby areas. Each of these may be set individually and this gives users the option of specifying literally thousands of different “user-defined” simulation scenarios.

This option is always available, but the “Designed Scenario” selection box provides a set of eight “pre-designed” scenarios that are likely to be of interest to many users. These scenarios highlight three broad hypotheses about factors relevant to producing segregation; namely, economic factors, housing discrimination, and ethnic preferences. The hypotheses are not mutually exclusive and so can be used in combination as well as alone. The eight pre-designed scenarios provide all possible combinations of the three. These are now reviewed in more detail.

**Scenario 1-No Segregation Factors.** In this scenario, no segregation-producing forces are active. Households can move without impediment from cost considerations or discrimination. High- and low-quality housing are distributed evenly throughout the city. Ethnic groups have similar status distributions. Households are not motivated by goals to live in high-status neighborhoods, high-quality housing, or areas with particular ethnic mixes.

Under this scenario, households move only because a portion of

them are “forced” to move in each “cycle” to simulate job transfers to a new city, the formation of new households, and other events that precipitate moves. When households move, they are not impeded by cost considerations or discrimination. But they also have no goals or motivations that would lead them to choose between available houses so they move randomly to the first available house they identify.

Segregation that emerges under this scenario thus reflects random rather than systematic forces in residential location. As a result, dissimilarity scores tend to be very low (e.g., 12-18), contact with members of the same group (i.e., isolation) closely matches population representation, and centralization is near zero for all groups.

**Scenario 2-Economic Factors Only.** Under this scenario several factors reflecting economic forces are activated. Households are motivated to seek high-quality housing and high-status neighborhoods. Area stratification is high with higher-quality housing being concentrated in outlying areas and lower-quality housing being concentrated in central areas. Moves are means tested. Minorities are disadvantaged in terms of socioeconomic status (and hence ability to purchase housing). All of these conditions reflect basic assumptions consistent with the hypothesis that economic factors produce ethnic segregation (Jaret 1995).

**Scenario 3-Discrimination Only.** In this scenario, no economic factors are active. White households are given strong preferences for in-group contact (i.e., they seek neighborhoods that are at least 95% white), but minority households have no ethnic preferences. And attempts by minority households to move into predominantly white neighborhoods are likely to be blocked by discrimination. These settings reflect assumptions that whites are highly prejudiced (i.e., wish to avoid residential contact with minority households) and are able to exclude minorities from white neighborhoods (Massey and Denton 1993; Yinger 1995; DeSena 1994).

**Scenario 4-Ethnic Preferences Only.** Under this scenario households are given preferences for neighborhood ethnic mix that closely correspond to the responses reported in survey-based studies (e.g., Bobo and Zubrinsky 1996; Clark 1991; Farley et al. 1994) of ethnic preferences. Whites have strong in-group preferences (i.e., seek 90% white neighborhoods) and do not have preferences for contact with other groups. Minority households have moderate in-group preferences (i.e., Blacks seek neighborhoods that are only 50% black, Hispanics seek neighborhoods that are only 50% Hispanic) and have a moderate preference for residential contact with whites (i.e., Blacks and Hispanics alike seek neighborhoods that are at least 30% white). Households consider ethnic mix in nearby areas as well as the

area their house (or prospective house) is located in. Economic factors and discrimination are not active. These settings reflect assumptions that households from different ethnic groups have specific preferences for in-group and out-group contact that influence their residential location choices.

**Scenario 5-Economics & Discrimination.** Under this setting economic factors are activated (as in Scenario 1) in combination with discrimination factors (as in Scenario 2).

**Scenario 6-Economics & Preferences.** Under this setting economic factors are activated (as in Scenario 1) in combination with ethnic preferences (as in Scenario 3).

**Scenario 7-Discrimination & Preferences.** Under this setting discrimination factors are activated (as in Scenario 2) in combination with ethnic preferences (as in Scenario 3). The discrimination only scenario includes ethnic preferences but limited only to white prejudice. The combination of discrimination and ethnic preferences implements ethnic preferences as specified under the “ethnic preferences only” scenario.

**Scenario 8-All Three Factors.** Under this setting all three factors are implemented in combination with ethnic preferences following those specified under the “ethnic preferences only” scenario.

**User-Defined Scenarios.** Any time the user makes a direct selection using one of the seven selection boxes on the second and third rows of selection boxes, the scenario will be labeled as “User-Defined”.

## Using the Program

SimSeg Lite allows users to design “scenarios” that reflect different assumptions about what segregating forces are “operating”. The program implements the scenario via algorithms that create relevant urban and socio-demographic structures (i.e., inequality and area stratification) and relevant micro-level behavior governing housing search, evaluation, and constraints on movement. It then allows these algorithms to operate over “time” and displays quantitative and graphical results to indicate the consequences for segregation.

**Specify the Scenario.** The first step in setting up an experiment is to implement a simulation “scenario” by using the selection boxes to set the model’s parameters. This defines a specific configuration of “virtual” segregation dynamics and conditions.

**Initialize the City Landscape.** The next step is to initialize the city landscape by clicking on the “Reset” button. The program then creates the appropriate status distributions for households in

each ethnic group, distributes housing across the city landscape, activates preferences and sets preference targets, and distributes households randomly to housing units.

**“Run” the Scenario.** The next step is to “run” the simulation from that point by clicking on the “Begin” and “Continue” buttons until it has run for a sufficient period of time (usually 30 cycles is adequate) to reveal whether the model’s algorithms will generate segregation. The user can assess the impact of segregation dynamics by observing the changes in quantitative segregation indices and by noting changes in the graphical representation of the city landscape.

## Assessing Outcomes<sup>6</sup>

The literature on measures of residential segregation recognizes five separate dimensions of segregation: uneven distribution, isolation, clustering, centralization, and concentration. SimSeg Lite directly measures three of them and provides visual feedback regarding a fourth.

**Uneven Distribution.** This reflects the extent to which groups are distributed unevenly across areas of the city. The point of reference is even distribution which obtains when a group’s percentage representation is the same in every neighborhood as it is in the city as a whole. SimSeg measures uneven distribution using the index of dissimilarity (D) – the most widely used measure of departure from even distribution. It ranges from 0 (exact evenness) to 100 (maximum departure from evenness).

Scores for White-Black segregation in US cities are typically in the range 50-90. Scores for White-Hispanic and White-Asian segregation tend to be lower. Scores may be loosely interpreted as follows: below 30 is very low; 30-45 is low, 45-60 is medium, 60-80 is high, and above 80 is very high.

**Isolation.** This reflects the degree to which members of a group are residentially isolated from other groups. This is affected by both uneven distribution and by relative group size. SimSeg Lite measures isolation using a “P\*” measure of co-ethnic contact. This registers the average residential contact that members of a group have with other members of their own group. It can take a maximum score of 100 (when all contact is within group). The minimum is determined by the group’s representation in the city population. The city-wide ethnic

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<sup>6</sup> Readers interested in an extended discussion of measuring segregation outcomes should consult Jaret (1995) (a good choice for undergraduate students) or Massey and Denton (1987).

mix in SimSeg Lite is fixed at 60% White, 20% Black, and 20% Hispanic. All else equal, these are the patterns of co-contact expected for all groups under conditions full integration.

Isolation is influenced by demographic conditions as well as uneven distribution. Isolation may be considered in *absolute* terms and, not surprisingly, larger groups tend to be more isolated. Isolation may also be considered in *relative* terms by comparing the amount of isolation to that expected under integration.

**Clustering.** Clustering reflects the degree to which areas where a group predominates occur near each other in urban space and form clusters or ghettos - distinct macro regions of contiguous neighborhoods with a highly homogeneous ethnic mix. The opposite of clustering is “checker boarding” – a pattern wherein ethnic neighborhoods are randomly distributed throughout the city. Clustering can be seen visually in the graphical representation of the city landscape. No single measure of clustering has gained popular usage in the research literature and most are too technical for the purpose at hand. In view of this, SimSeg Lite uses an index of clustering chosen for its ease of explanation and interpretation.

Specifically, the program measures clustering as the percentage of households in the group residing within “ethnic clusters”. A household is classified as residing within an ethnic cluster based on two criteria. The first concerns the ethnic mix of the household’s immediate area of residence. The co-ethnic presence (i.e., same group representation) in the area must be at least 60%.

The second criteria concerns the ethnic mix in nearby areas. Here one of two conditions must be met. At least three contiguous areas must each separately meet the 60% co-ethnic presence standard. Or, there must be at least 50% co-ethnic representation in the combined population of *all* contiguous areas.

The maximum possible score on the measure is 100 (when all households in a group reside in ethnic clusters. The minimum score is 0. Like isolation, clustering is shaped both by patterns of uneven distribution and by relative group size. Thus, since whites are 60% of the population in the SimSeg Lite simulation, it is difficult for the group to get a low clustering score.

**Centralization.** This reflects the degree to which members of a group are concentrated in neighborhoods near the center of the city. SimSeg measures centralization on a scale ranging from -100 to 100. As a “rule of thumb”, the scores may be interpreted as follows.

- 100 – maximum possible centralization
- 50 – very high centralization
- 20 – high centralization
- 0 – neutral distribution
- 20 – low centralization
- 50 – very low centralization
- 100 – minimum possible centralization

Centralization scores are calculated in the following way. (1) Each housing unit is assigned a percentile score for distance from the city center (e.g., 60 = farther from the city center than 60% of all housing units). (2) The mean (Y) for these percentile distance scores is calculated separately for each ethnic group. (3) These mean scores (Y) are converted to centralization scores (CS) using the formula:

$$CS = (50-Y) \cdot (2 \cdot 100) / (100-P)$$

where P is the group's percentage in the city population.

The logic for the formula can be explained as follows. The term (50-Y) captures deviation from neutral distribution (since 50 is the expected percentile distance score under even distribution). The term (2·100) is a scaling adjustment to convert the result to whole numbers ranging between -100 and 100. The term (100-P) is included in the formula to adjust for the fact that the minimum and maximum scores for Y for any group are P/2 and 100-(P/2), respectively. Thus, the maximum range of Y for any group is (100-P), the term in the denominator.

**Concentration.** This reflects the degree to which members of a group are concentrated in a small geographic area due to disproportionate representation in high-density neighborhoods. Since all neighborhoods in the SimSeg simulation have the same density (i.e., all neighborhoods are identical in size and have an identical number of housing units), this dimension of segregation is not relevant and is not measured here.

In the “real world” densely settled areas tend to be centrally located. So one might speculate that factors that produce centralization will also produce concentration.

## Assessing Effects

Effects of specific combinations of variables can be assessed in at least two different ways. One way is to change the settings of model parameters over the course of a single simulation experiment. The other is to design, run, and compare two separate, strategically crafted

simulation scenarios.

**Simulating Interventions “On the Fly”.** Several model parameters can be changed during the course of a single simulation experiment. In fact, five of the seven selection boxes that reflect basic model parameters can be changed “on the fly”. Only two, area stratification and ethnic inequality, are fixed once the simulation is underway. The other five model parameters can be changed at the conclusion of any simulation “stage”.

The user can, thus, turn settings “on” or “off” or select new values and then click on the “Continue” button to see what effect the changes have on segregation patterns. Such experiments are termed “multi-stage” experiments.

**Strategically Crafted Comparisons.** A different approach must be used whenever the two “fixed” characteristics of “inequality” and “area stratification” are involved. This approach may be also be used to assess the effects of other model parameters, but it is the only option with the two in question. The approach is to carefully design two experiments that differ in the settings of model parameters. Run experiments using each setting. And make careful notes on outcomes so the impact on segregation outcomes of varying different model settings can be documented.

**Systematic Analysis.** Whether the first or second method is used to assess the impact of varying a given model parameter, careful, systematic analysis is required to truly establish the effect under consideration. The SimSeg Lite model is indeterminate in the sense that stochastic (i.e., random) forces within the model insure that it is extremely unlikely that two simulation experiments will be identical. Given this, segregation outcomes are likely to vary from one experiment to another even when model parameter settings are identical in ever respect. Thus, it is usually necessary to run experiments several times to insure that the effect observed is observed with sufficient regularity to be expected with confidence. This is true for both single, multi-stage experiments and for strategic pairs of experiments.

A more rigorous application of systematic analysis would involve prior specification of expected effects (e.g., statement of a hypothesis) and careful recording of effects over many repeated trials of the relevant experiments. Instructions for performing such analyses and forms for recording results are provided in documents available via links on the SimSeg Lite page of the VLAB-RESI website.

A further layer of rigor can be added by conducting statistical analysis of the results to formally establish the magnitude and statistical significance of the effects under consideration. Fortunately, this often amounts to “overkill” for assessing many of the effects that can

be explored using the model. That is, while rigorous analysis is never unwelcome, more casual experimentation often produces effects that are dramatic and obviously “significant”. These can certainly provide tentative insights about segregation dynamics, insights that may well be confirmed when more careful analysis is conducted.

## Interpreting Model-Based Results

The previous section comments on how to “assess” effects and even “test” hypotheses. How far can this go? What kinds of substantive interpretations can be sustained based on analysis of results produced by SimSeg Lite? At one level the answer is easy. If the goal is to assess effects *solely* within the framework of the SimSeg Lite model, interpretations of effects are straightforward. This is not a trivial or uninteresting point. It can be very useful to explore a simplified theoretical model just for the sake, in the short run, of coming to better understand the model and its behavior. The model implements a certain representation of the world and outcomes in that particular world may be instructive if only for indicating that a more complicated model is needed to capture essential characteristics of “real world” systems.

The SimSeg Lite model is relatively simple. But that does not mean that it is easy to predict what will happen when the model is run using different parameter settings. Learning just this one basic fact can be quite valuable. It leads to a very real understanding of how difficult it can be to understand complex systems such as those involved with residential segregation.

## Avoid Naive Generalizations

The SimSeg Lite model is not intended to directly reproduce or predict actual residential patterns in “the real world”. This does not mean that findings generated by the SimSeg Lite model do not hold in the real world. Some might. For example, under the SimSeg Lite model, “considering ethnic mix in nearby areas” produces “clustering” while “ignoring nearby ethnic mix” produces “checker boarding”.<sup>7</sup> Real cities usually exhibit strong clustering. Perhaps consideration of ethnic mix in nearby areas plays a role in creating clustering in real cities. The problem of course is that the SimSeg Lite model too simple to provide a sound basis for generalizing about “real” segregation pat-

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<sup>7</sup> This occurs under simulations where inequality and area stratification are both set to “medium” or lower and ethnic preferences are set to “survey preferences”.

terns in real cities in any authoritative way. Thus, one should never generalize naively from the SimSeg Lite model to real cities. Instead, it is better to view findings obtained using SimSeg Lite as “suggestive” or “preliminary” in nature; the question of whether they reflect “real world” dynamics is one that can motivate the user to dig deeper into the research literature to get an even better basis for making a judgment.

### ***Technical Implementation of the Model***

At a technical level, the SimSeg Lite program includes a welter of algorithms and technical procedures for implementing the model. While the model is in many respects a simple one, the technical details are significantly beyond most of its intended user audience. Thus, the program tries to insulate the user from these details, leaving the user to interact with the model via selection boxes that express model settings in more intuitive terms. The interested reader can find a discussion of the technical features of the SimSeg Lite model in separate documents available through links at the SimSeg Lite page at the VLAB-RESI website.

### **Concluding Comments**

The SimSeg Lite program provides a useful tool that new students of racial segregation can use to gain an intuitive appreciation for many of the concepts used in segregation analysis. However, as noted above, the SimSeg Lite model is greatly simplified relative to “real world” segregation dynamics and should not be interpreted naively. Thus, I strongly encourage the reader to pursue their interest in racial segregation much further. A fuller understanding of segregation theory can be obtained by authoritative overview discussions provided by Massey and Denton (1993) and others (e.g., Farley and Allen, 1986; White 1987). Given the importance of racial segregation in American life, an educated person should get as broad a perspective on this sociological phenomenon as possible. For the reader who is new to the subject, Jaret (1995) provides an especially good first introduction to many of the issues considered here.

### **Acknowledgements**

My inspiration for the SimSeg Lite program traces to the work of Thomas Schelling (1971; 1972). Ironically, the original inspiration was negative. While I appreciated and admired Schelling’s formal analyses of segregation dynamics, I felt that in some respects they were incomplete and even misleading. Thus, I set out to develop a richer and more complex simulation model on the presumption that it would show that the segregation-producing effects of ethnic preferences that Schelling documented in extremely simple models would not hold up in more complicated and realistic models.

In the course of exploring the issue off and on for over a decade, I found that, at least in simulation models, the effects Schelling identified were stronger and more robust than I had expected. This led me to rethink my own understanding of segregation dynamics and to turn to simulation modeling as a strategy for research and teaching. Now I draw positive inspiration from Schelling’s work and from simulation modeling. By exploring such models, I have learned many things I would not otherwise have learned about residential segregation. And I have found that the models can be very useful in teaching.

I have received support to develop the SimSeg Lite program from several sources that I would like to acknowledge here. The National Science Foundation has provided significant direct funding support for this project. The Department of Sociology at Texas A&M University, headed by Dr. Rogelio Saenz, has provided important matching support for the project. The Race and Ethnic Studies Institute at Texas A&M University, directed by Dr. Mitchell F. Rice, supported the development of the proposal submitted to the National Science Foundation. I am pleased to take this opportunity to acknowledge these important sources of support for the project.

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When SimSeg Lite is used in instruction, the preparation of student research papers, or other related activities, the program should be identified and referenced appropriately. The suggested citation for the program is:

Fossett, Mark A. 2001. SimSeg Lite: A Computer Model for Exploring Residential Segregation Dynamics. Department of Sociology and Race and Ethnic Studies Institute, Texas A&M University, College Station, Texas.

Similarly, when the VLAB-RESI web site is used in instruction, the preparation of student research papers, or other related activities, the site should be identified and appropriately referenced. The suggested citation is:

Fossett, Mark A. 2001. VLAB-RESI: A Virtual Laboratory for the Study of Racial and Ethnic Stratification and Inequality. Website maintained by the Department of Sociology and Race and Ethnic Studies Institute. Texas A&M University, College Station, Texas. (<http://vlab-resi.tamu.edu>)

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## Appendix A System Requirements

The SimSeg Lite program should run well on computers with the following capabilities and configurations:

*High- or medium-resolution display.* A display set to 1024x768 resolution (or higher). SimSeg Lite will run on computers with a screen resolution as small as 800x600, but less effectively.

*Web browser software.* One of the following web-browsers: Microsoft Internet Explorer (version 5 or higher) (recommended); or Netscape Navigator (version 4.5 or higher).

*Java capability.* The browser program must be configured to run Java programs.

*Memory.* The computer must have sufficient memory to run the browser program and also the browser's java "engine" that gives it the capability to run the SimSeg Lite java applet. It is not possible to say exactly what amount of memory is needed for satisfactory performance (too many factors must be considered). However, symptoms of inadequate memory include slow performance, and badly "behaved" or incomplete graphic displays.

*Processing power.* Most contemporary computers have more than adequate processing speed to provide satisfactory performance for SimSeg Lite. Any CPU comparable in performance to a 450MHz Pentium III processor should be adequate.<sup>8</sup>

*High-speed internet access.* The SimSeg Lite program loads from the VLAB-RESI web site. While the program and associated documents have been developed with an eye toward keeping programs and documents small so they will load quickly, users with lower-speed internet connections (e.g., conventional dial-up modems) may find loading times unsatisfactory. Users with faster internet connections (e.g., high-speed ethernet connections commonly found on college campuses and cable modem and DSL connections increasingly found in homes) should experience good performance.

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<sup>8</sup> At this time, we have not conducted performance tests using other "flavors" of computers (e.g., Macintosh, Unix workstations, etc.). Thus, we make no recommendations for other "platforms". In principle, web pages and Java applets should work identically across platforms. In practice, this is not the case.

## Appendix B

### Saving and Printing Images

Notice that SimSeg Lite does not have a program control for printing or capturing the images it displays. It is possible to print and/or capture its images, but this is not done directly through the SimSeg Lite program. Instead, this is accomplished indirectly by using the capabilities of the browser program, or the operating system used in combination with programs that can manipulate and print graphics images.

This section outlines methods for saving and printing images. Similar instructions can be found in SimSeg Lite' "Help" system.

#### **Method 1: Direct Printing**

If you use the Microsoft Internet Explorer browser (version 5.0 or higher), you may be able to print displayed images directly from within your browser and get good results.<sup>9</sup> To do so, take the following actions.

- a. Move your pointer to the border region surrounding the applet. (Usually this will be a small yellow border around a maroon applet frame.)
- b. Next, right click on the border region. This will call up an Internet Explorer menu that includes an option to print. Choose that option.
- c. A print dialog box will appear. Under the "Print Frames" heading, check the option to print "Only the selected frame" (since the applet is running in a browser "frame").
- d. Click on the "Properties" button of the print dialog box to configure your printer for printing graphics. (You can skip this step if the printer's default settings are set appropriately for graphics printing.)
- e. Click on the "OK" button on the print dialog box to print. If all goes well, the applet image will print successfully.

This direct method of printing is convenient, but may not work predictably under some combinations of browser and printer configurations. Common problems include distorted images, poor image quality for the printed image, and poor matching between screen and printer colors. You may be able to overcome these problems by

changing your browser or printer settings. So be prepared to experiment until you find a solution that is satisfactory.

#### **Method 2: Capture the Image, Then Print or Save**

The second method takes multiple steps but should work reliably on all computers running Windows. It relies on Windows' ability to copy images of either the active window or the entire screen to the Windows "clipboard" (a temporary storage area where the operating system can hold text and images). Once an image is copied to the clipboard, it can then be "pasted" into Windows programs that can accept graphics images.

##### *Step 1: Capture the Image*

Make sure the browser window is the active window. (It normally will be unless you are switching between programs while using your browser).

Copy the browser window contents to the clipboard by pressing **Alt-Print Screen** (i.e., press the "ALT" and "Print Screen" keys at the same time).

Alternatively, copy the entire screen to the clipboard by pressing **Print Screen**.

Windows does not provide any feedback to show that the window (or screen) has been successfully copied to the clipboard. So you cannot easily tell that you have accomplished your intended task. However, the process is reliable and in most cases the image is now copied to the clipboard and from there can be accessed by other Windows programs.

##### *Step 2: Paste the Image*

Start a Windows program that will accept graphics images from the clipboard. The Windows "Paint" program is one such program. Word and other popular word processing programs also will accept graphics images. And, of course, specialized graphics editing programs such as PhotoShop will work.

Click on the "Edit" option of the program's main menu.

Click on the "Paste" option on the Edit submenu.

At this point, the image should appear in the program and can be manipulated (e.g., edited, cropped, sized, etc.) as the program's capabilities permit.

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<sup>9</sup> Note: The direct method of printing is not available when using the Netscape Navigator browser.

### *Step 3: Print and/or Save the Image*

Use the program's capabilities to either print the image or save it to disk as a graphics file.

#### *Note on Image Formats*

Graphics images are saved to the clipboard as “bitmap” images. Also, after a program has imported an image from the clipboard, it will typically save the image to disk using the bitmap image format unless the user intervenes and specifically instructs the program to use a different image format.

The significance of this is that bitmap image files can be large (e.g., on the order of 2MB). The size of the graphics file can often be reduced dramatically by using the graphics editing program's ability to save the image to a format that uses “compression” to reduce the size of the file. For example, the “GIF”, “JPG”, and “PNG” formats are graphics file formats that will greatly reduce the size of the file, perhaps by a factor of 20 or more. For this reason, they are widely used to create images for web documents and other applications where file size is an important consideration.

However, when using GIF, JPG, PNG, and other popular graphics file formats, be careful to note whether the format conversion preserves the image's original colors. If the colors are altered, key information may be lost. (Some programs' conversion routines perform better in this regard than others. For example, the Windows Paint program sometimes alters color schemes when it converts images to compressed formats.)