DEPRECIATION FUNDAMENTALS

NASUCA

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Outline

- Introduction
- Accounting and Computations
- Depreciation Systems
- Mortality Concepts
- Actuarial Analysis
- Simulated Plant Record Model
- Removal Cost and Salvage
- Ratemaking Issues

Introduction

- Industrial Revolution
- Early Supreme Court Decisions
- Definitions
- Forces of Retirement
- Current Concepts

INTRODUCTION

- Industrial Revolution
  - Capital now being "consumed"
  - Viewed depreciation as a "recovery pool"
  - PUCs instrumental in establishing early uniform concepts in depreciation

INTRODUCTION

- Early Supreme Court Decisions
  - 1876 – Not customary to consider depreciation as a business expense
  - 1907 – Large capital additions should not be expensed in one year (matching principal)
  - 1909 – *Knoxville* – utility is entitled to recover depreciation expense
  - 1934 – *Lindheimer* – recognized straight-line method and original cost basis
  - 1944 – *Hope* – reaffirmed Lindheimer's cost basis recognition

INTRODUCTION

- Definitions
  - *Lindheimer* (1934)
    - "Broadly speaking, depreciation is the loss; not restored by current maintenance, which is due to all the factors causing the ultimate retirement of the property. These factors embrace wear and tear, decay, inadequacy and obsolescence."

INTRODUCTION

- Definitions
  - Interstate Commerce Commission (1931)
    - "Depreciation is the loss in service <u>value</u> not restored by current maintenance and incurred in connection with the consumption or prospective retirement of property in the course of service from causes against which the carrier is not protected by insurance, which are known to be in current operation, and whose effect can be forecast with a reasonable approach to accuracy"

INTRODUCTION

- Definitions
  - AICPA (1944)
    - "Depreciation accounting is a system of accounting which aims to distribute cost or other basic value of tangible capital assets, less salvage, over the estimated useful life of the [property] in a systematic and rational manner. It is a process of allocation, not of valuation."

INTRODUCTION

- Forces of Retirement ("Mortality")

Physical Forces

- Wear & decay
- Action of the elements
- Accidents

Functional Forces

- Inadequacy
- Obsolescence
- Changes in technology
- Changes in demand
- Regulatory requirements
- Managerial discretion

Contingent Forces

- Casualties
- Disasters
- Remote obsolescence

Depreciation Systems, p. 276

INTRODUCTION

- Current Concepts
  - Value vs. Cost Allocation
    - The Value Concept
      - In 1930, Supreme Court in *West* found that depreciation expense should be based on present value rather than original cost
      - Not consistent – value can deteriorate slowly over time or immediately (e.g., new car of the lot)
      - Would require extensive, annual appraisals, while depreciation expense is recorded monthly for earnings reports
      - *West* ultimately overruled by *Lindheimer* and *Hope* – annual depreciation should be based on original cost

INTRODUCTION

- Current Concepts
  - Value vs. Cost Allocation
    - The Cost Allocation Concept
      - Since *Lindheimer* and *Hope*, the original cost of plant is allocated over its useful life systematically
      - Promotes three fundamental accounting principles:
        - Verifiability
        - Neutrality
        - Matching
      - Book depreciation is often called "capital recovery"
        - Return "on" investment (ROE)
        - Return "of" investment (depreciation)

NARUC Manual, pp. 11-12

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Accounting and Computations

- Principles
- Computations
- Accounting Example

Accounting and Computations

- Principles
  - Depreciation accounting charges depreciable cost (original cost less net salvage) over the assets' useful life
  - Depreciation is viewed as an operating expense, though no cash is expended

Accounting and Computations

- Principles

Summarized Debit and Credit Rules		
Account Type	To Increase	To Decrease
Asset	Debit	Credit
Liability	Credit	Debit
Equity	Credit	Debit
Revenue	Credit	Debit
Expense	Debit	Credit

ACCOUNTING AND COMPUTATIONS

- Basic Formulas

$$Annual\ Accrual\ (\$) = \frac{Depreciable\ Base}{Service\ Life}$$

- Depreciable Base = Original Cost – Net Salvage
- Net Salvage = Gross Salvage – Removal Cost
- Thus, AA = [Cost – (GS – RC)] / Useful Life
- Assets = Liabilities + Owners' Equity
- Net Income = Revenues – Expenses

ACCOUNTING AND COMPUTATIONS

- Example
  - Plant costing $100,000 is placed in service
  - Estimated life is 10 years
  - Plant is retired at the end of 10 years
  - Estimated gross salvage is $15,000
  - Estimated cost of removal is $5,000
  - Depreciation recorded on straight-line basis

Accounting and Computations

- Example
  - Calculate annual accrual expense

$$Annual\ Accrual = \frac{Cost - (Gross\ Salvage - Removal\ Cost)}{Service\ Life}$$

$$\$9{,}000 = \frac{\$100{,}000 - (\$15{,}000 - \$5{,}000)}{10\ years}$$

Accounting and Computations

- Basic Accounting Example

  - Plant acquired and placed in service:

Plant in Service	100,000	
Cash		100,000

  - Annual depreciation expense accrual (x10):

Depreciation expense	9,000	
Accumulated depreciation		9,000

Accounting and Computations

- Basic Accounting Example
  - Retirement of plant:

Accumulated depreciation	100,000	
Plant		100,000

  - Removal cost:

Accumulated depreciation	5,000	
Cash		5,000

Accounting and Computations

- Basic Accounting Example
  - Sale of plant (gross salvage):

Cash	15,000	
Accumulated depreciation		15,000

ACCOUNTING AND COMPUTATIONS

	Assets	= Liability	+ Equity	Revenue	- Expenses	= Net Income
Plant Acquired						
Plant	100,000					
Cash	(100,000)					
Dep. Exp. (x10)						
Dep. Exp.					90,000	
Accum. Dep.	(90,000)					
Retirement						
Accum. Dep.	100,000					
Plant	(100,000)					
Removal Cost						
Accum. Dep.	5,000					
Cash	(5,000)					
Sale						
Cash	15,000					
Accum. Dep.	(15,000)					

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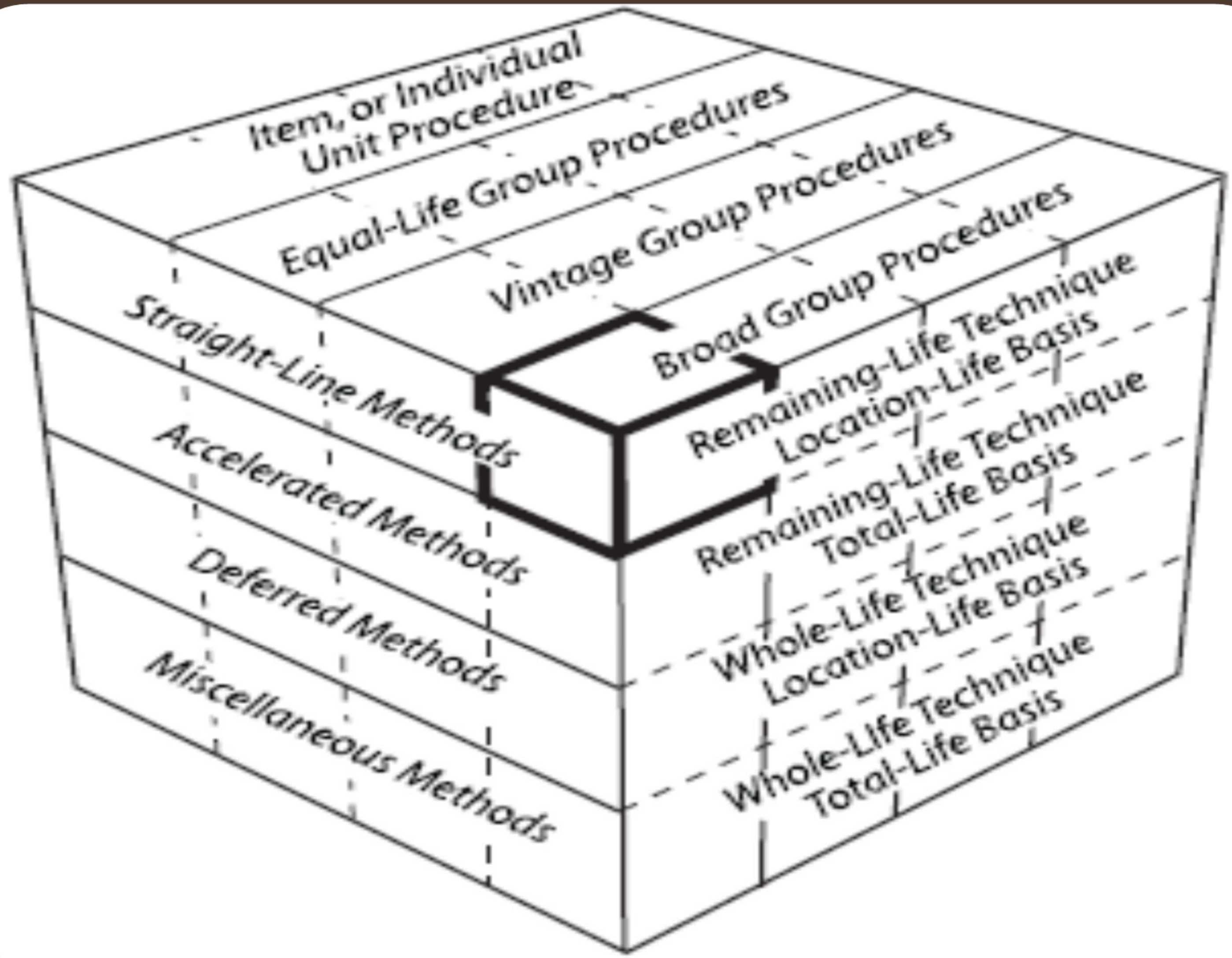
Depreciation Systems

- Introduction
- Allocation Methods
- Grouping Procedures
- Application Techniques
- Analysis Models

DEPRECIATION SYSTEMS

- Introduction
  - Dynamic system with inputs and parameters
  - Objective: timely recovery of capital
  - Fragmented field = nonstandard vocabulary
  - Four system parameters:
    - Allocation Methods
    - Grouping Procedures
    - Application Techniques
    - Analysis Models

Depreciation Systems



Depreciation Systems

- Allocation Methods
  - Review depreciation accounting definition:
    - "Depreciation accounting . . . aims to distribute cost . . . over the estimated useful life of the [property] in a systematic and rational manner." (AICPA)
  - Allocation may be based on:
    - Time (age-life methods)
    - Units of Production

DEPRECIATION SYSTEMS

- Allocation Methods
  - Age-Life Methods
    - Straight-line Method
      - Rate is constant over each period
      - Formula:
        - Annual Accrual = $\frac{\text{Depreciable Cost}}{\text{Service Life}}$
      - Most common method used in this context
    - Accelerated Methods
      - Double declining balance
      - Sum of the years digits

Depreciation Systems

- Grouping Procedures
  - Analyzing groups is more efficient than individual units
  - Groups should contain homogenous units
  - An individual unit has a single life, whereas a group has a dispersion of lives
  - Types of grouping procedures
    - Average life
    - Equal life

DEPRECIATION SYSTEMS

- Grouping Procedures
  - Average Life
    - Constant annual rate based on average life of the group is applied to surviving property
    - Treats each unit as though its life is equal to the average life of the group
    - Assets with lives longer/shorter than the average will over/under depreciate

Depreciation Systems

- Grouping Procedures
  - Average Life Example
    - Property group with two units:
      - Unit 1: $4,000 cost with 4-year life
      - Unit 2: $6,000 cost with 8-year life
    - Average life = $\frac{[(4{,}000 \times 4) + (6{,}000 \times 8)]}{10{,}000} = 6.4$
    - Average life accrual rate = 1 / 6.4 = 15.63%

This example is from Depreciation Systems, pp. 81-83

Depreciation Systems

- Grouping Procedures

SL-AL System

Year	Balance	Retired	Rate	Annual Accrual	Accum. Deprec.
2006	10000		15.63%	1563	0
2007	10000		15.63%	1563	1563
2008	10000		15.63%	1563	3125
2009	10000	4000	15.63%	1563	4688
2010	6000		15.63%	938	2250
2011	6000		15.63%	938	3188
2012	6000		15.63%	938	4125
2013	6000	6000	15.63%	938	5063
2014	0				0

Depreciation Systems

- Grouping Procedures
  - Equal Life
    - Property is divided into subgroups that each have a common life
    - Treats each unit in the group as though its life was known
    - May result in higher annual accrual rates for growing plant
    - Also known as "unit summation."

DEPRECIATION SYSTEMS

- Grouping Procedures
  - Equal Life Example
    - Consider the same scenario except with straight-line – equal life group rates
    - Divide the property in subgroups with common lives

This example is from Depreciation Systems, pp. 81-83

Depreciation Systems

- Grouping Procedures

SL-ELG Accrual Rate Calculation

Group	Group Amount	Group Life	Group Rate	Annual Accrual 2006-09	Annual Accrual 2010-14
A	4000	4	25.00%	1000	
B	6000	8	12.50%	750	750
		Annual accruals		1750	750
		Balance during interval		10000	6000
		Annual accrual rate %		17.50%	12.50%

Depreciation Systems

- Grouping Procedures

SL-ELG System

Year	Balance	Retired	Rate	Annual Accrual	Accum. Deprec.
2006	10000		17.50%	1750	0
2007	10000		17.50%	1750	1750
2008	10000		17.50%	1750	3500
2009	10000	4000	17.50%	1750	5250
2010	6000		12.50%	750	3000
2011	6000		12.50%	750	3750
2012	6000		12.50%	750	4500
2013	6000	6000	12.50%	750	5250
2014	0				0

Depreciation Systems

Contrasting AL and ELG Procedures

SL-AL System

Year	Balance	Retired	Rate	Annual Accrual	Accum. Deprec.
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2011	6000		15.63%	938	3188
2012	6000		15.63%	938	4125
2013	6000	6000	15.63%	938	5063
2014	0				0

SL-ELG System

Year	Balance	Retired	Rate	Annual Accrual	Accum. Deprec.
2006	10000		17.50%	1750	0
2007	10000		17.50%	1750	1750
2008	10000		17.50%	1750	3500
2009	10000	4000	17.50%	1750	5250
2010	6000		12.50%	750	3000
2011	6000		12.50%	750	3750
2012	6000		12.50%	750	4500
2013	6000	6000	12.50%	750	5250
2014	0				0

DEPRECIATION SYSTEMS

- Application Techniques
  - Application techniques refer to the way the depreciation rate is to be applied to a utility's plant categories
  - There are two commonly used techniques:
    - Whole Life
      - Allocates cost over total life of plant
    - Remaining Life
      - Allocates cost less accumulated depreciation over the remaining life of plant

Depreciation Systems

- Application Techniques
  - Estimates must be periodically revised
  - Calculated Accumulated Depreciation:
    - "CAD" is the calculated balance that would be in the AD account at a point in time using current depreciation parameters
  - Large imbalances between AD and CAD may require adjustment to AD

DEPRECIATION SYSTEMS

- Application Techniques
  - Whole Life
    - WL Accrual = $\frac{\text{Cost – Avg. Net Salvage}}{\text{Average Service Life}}$
    - Reserve Imbalance
      - The difference between the CAD and the accumulated depreciation account
      - Imbalance may be amortized over a set period of time (e.g. 10 years)
      - Or may be amortized over the remaining life of the property (the remaining life technique does this automatically)

Depreciation Systems

- Application Techniques
  - Remaining life accrual formula:
    - Annual Accrual (AA) =

$$\frac{\text{Plant} - \text{AD} - \text{Future Net Salvage}}{\text{Average Remaining Life}}$$

DEPRECIATION SYSTEMS

- Analysis Models
  - Two ways of viewing life characteristics of vintage property groups:
    - Broad group
      - All units within an account are viewed as one group
      - E.g. – Acct. 355 (poles) all analyzed together
    - Vintage group
      - Each vintage (placement year) within an account is considered to be a separate group
      - E.g. – Poles placed in 2005, 2006, etc. are analyzed separately

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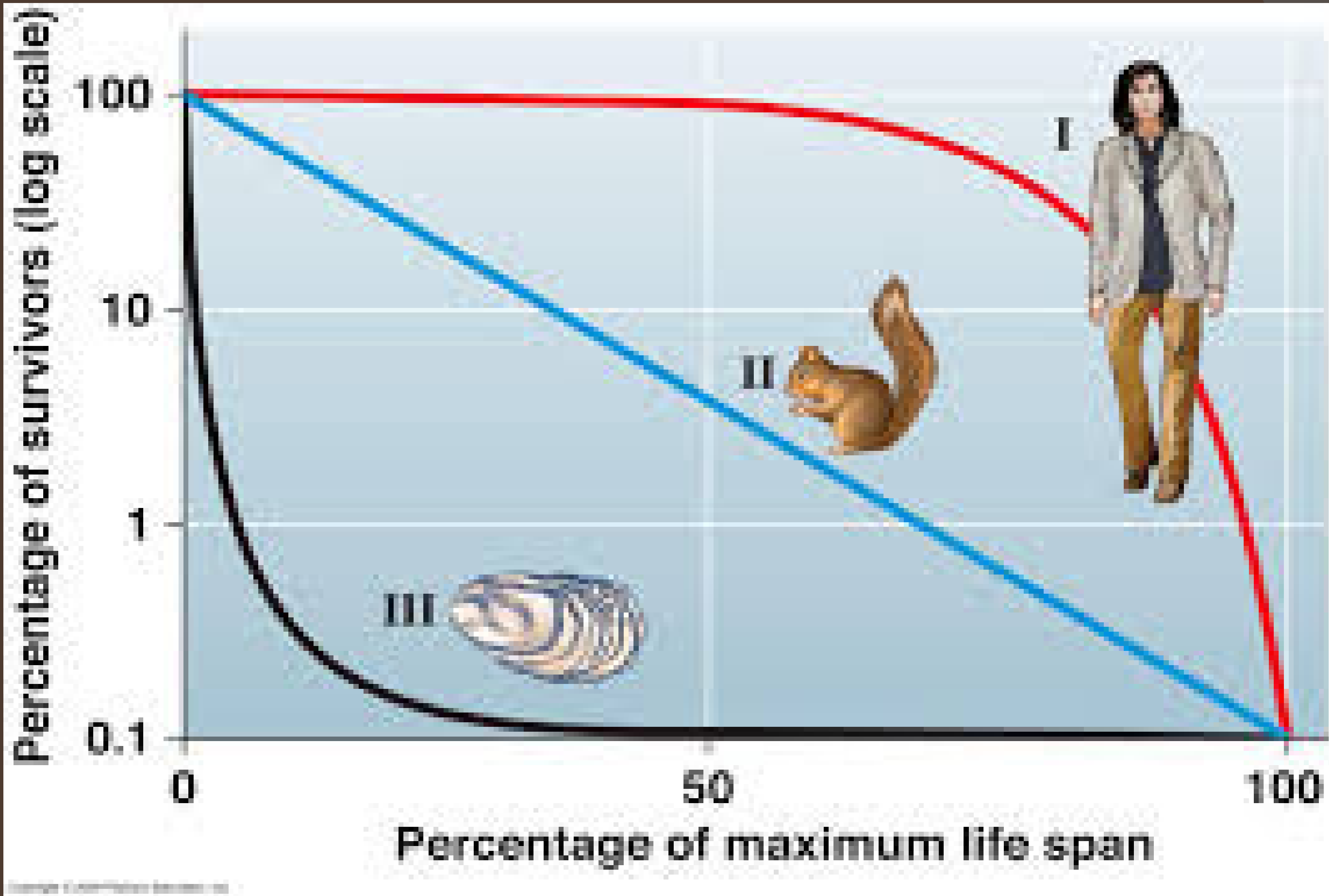
MORTALITY CONCEPTS

- Introduction
- Iowa Curves
- Types of Lives

Mortality Concepts

- Introduction
  - Analysis of industrial property rooted in the study of lives of human populations
  - Actuarial analysis is used by insurance companies to predict life expectancy
  - When dealing with groups, a single number is inadequate to describe life characteristics

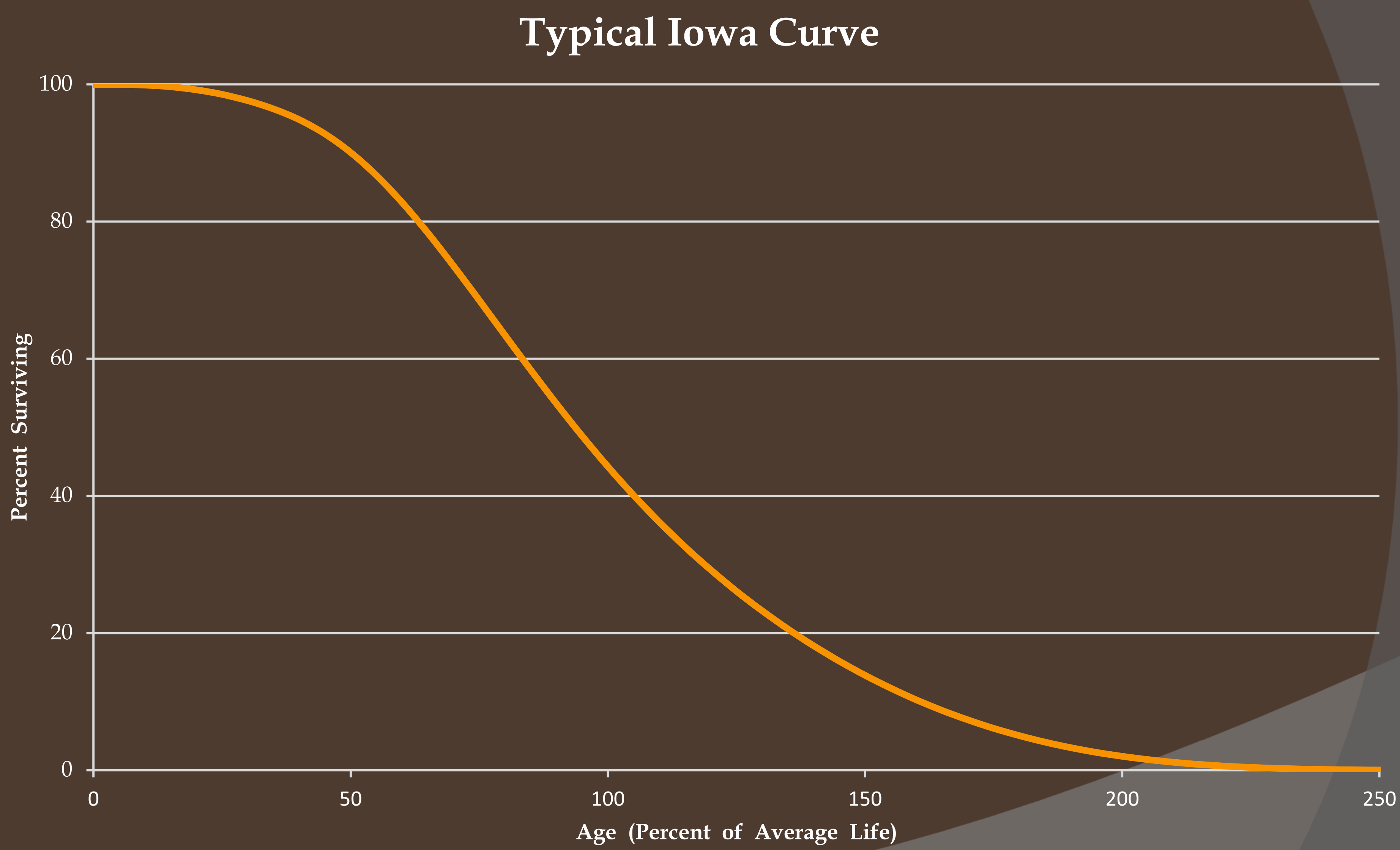
MORTALITY CONCEPTS



MORTALITY CONCEPTS

- Introduction
  - Survivor curve – graph of the percent of dollars surviving as a function of age
  - Frequency curve – a graph of the frequency of retirements as a function of age
  - These are used to describe the life characteristics of industrial property

MORTALITY CONCEPTS



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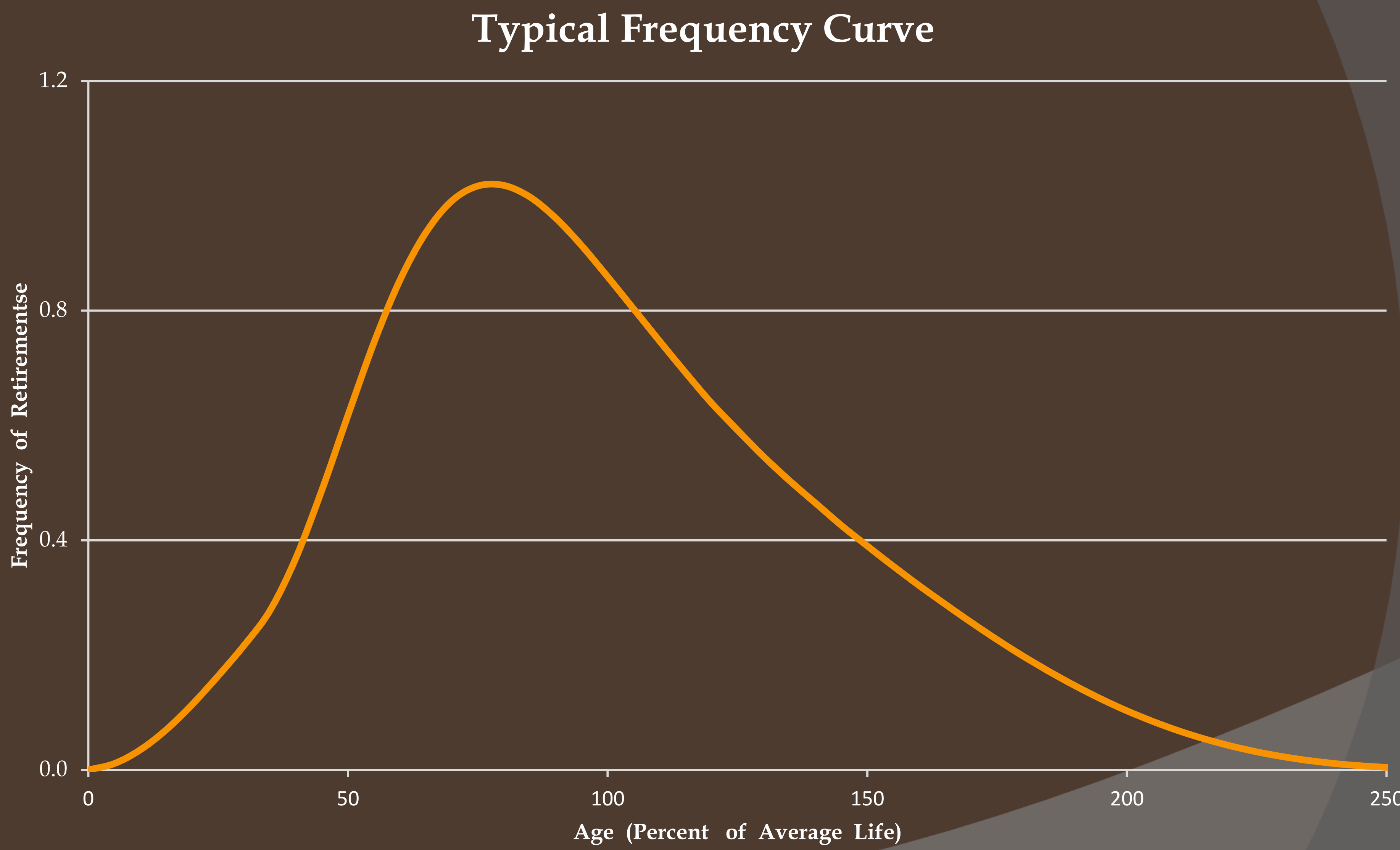


Mortality Concepts

- Iowa Curves
  - Developed over several decades starting in the early 1900s.
  - 1931 – Kurtz and Winfrey published 13 curve types
  - 1935 – Winfrey expanded to 18 curves
  - 1980 – Russo confirmed continued validity of Iowa curves
  - Today, total there are 31 "Iowa curves"

See Bulletin 125 for Iowa curve formulas. Iowa curve tables also published in Depreciation Systems

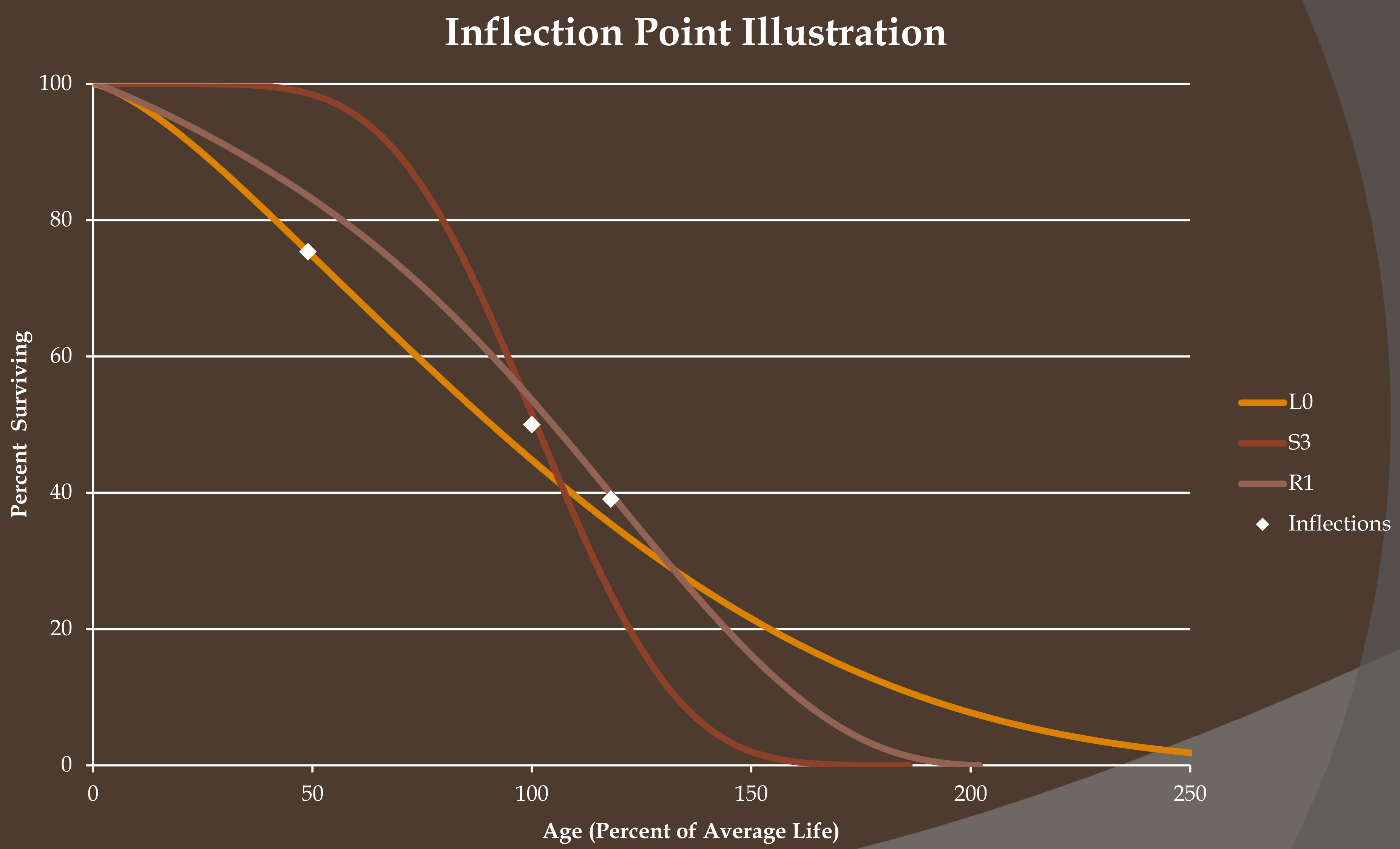
Mortality Concepts

- Iowa Curves
  - Three classification variables:
    - Modal location
    - Average life
    - Variation of life

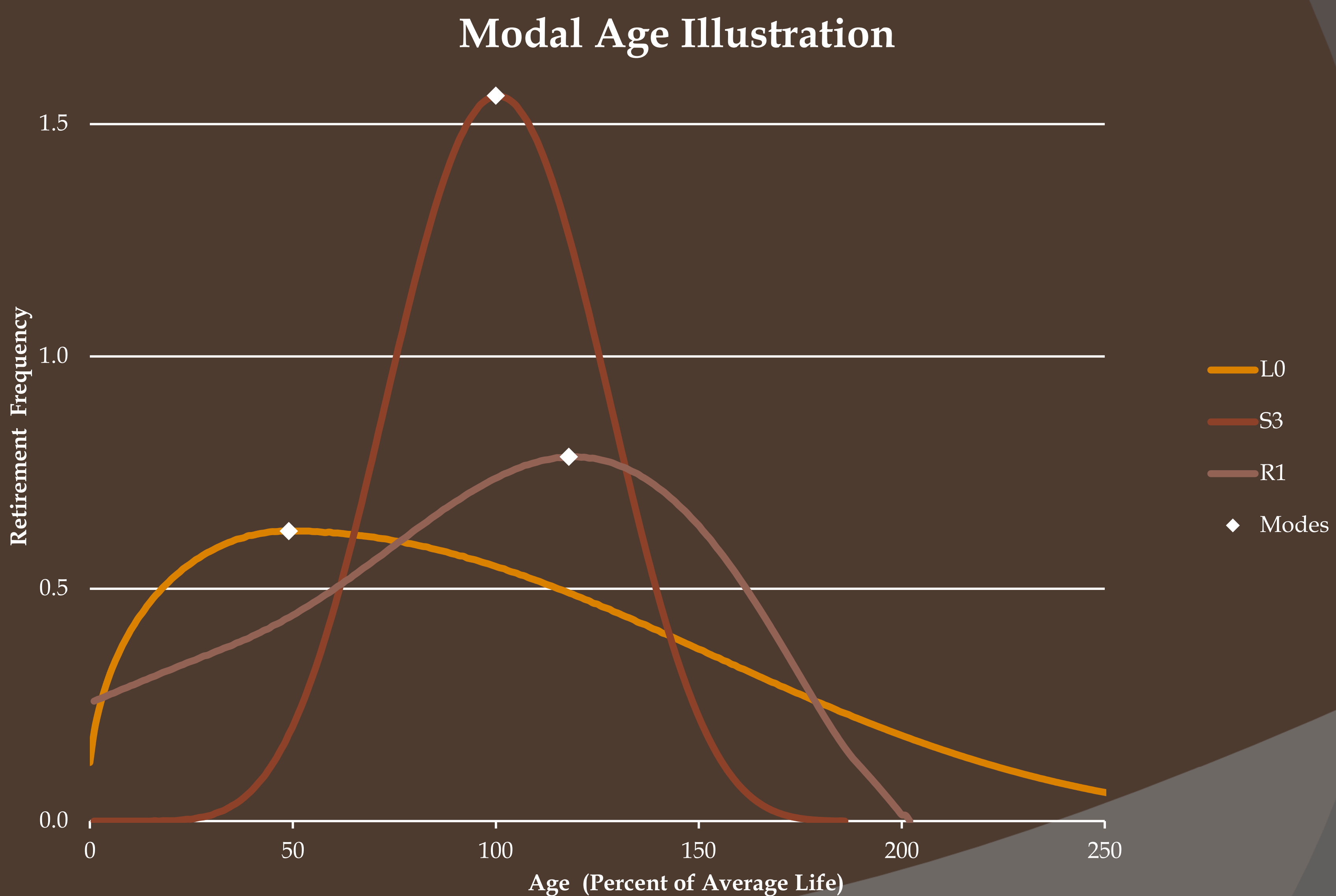
MORTALITY CONCEPTS

- Iowa Curves
  - Modal location
    - Age of greatest rate of retirement
    - Highest point on frequency curve and steepest point on survivor curve
    - Modal families:
      - 6 left modal curves (L0, L1, L2, L3, L4, L5)
      - 5 right modal curves (R1, R2, R3, R4, R5)
      - 7 symmetrical curves (S0, S1, S2, S3, S4, S5, S6)

Mortality Concepts



Mortality Concepts



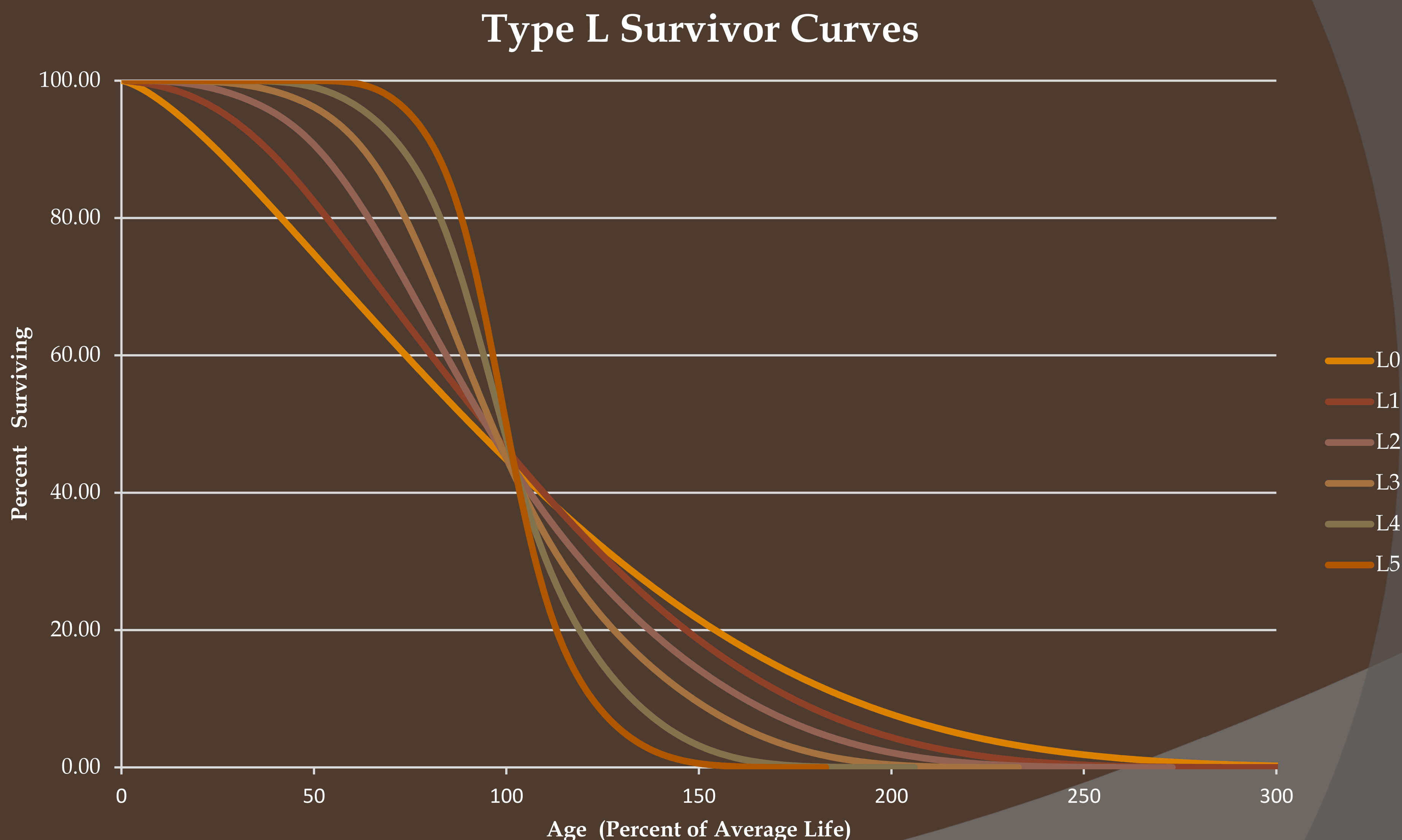
Mortality Concepts

- Iowa Curves
  - Average Life
    - Age (x-axis) is expressed as a percentage of average life
    - This makes curves adaptable to property of different ages
    - Each curve can be modified to forecast property groups with various average lives

Mortality Concepts

- Iowa Curves
  - Variation of Life
    - Shown by numbers (e.g., L1, L5)
    - Represent heights of modes
    - Higher number = higher mode = lower variation = smaller maximum life
  - All three variables used to describe a curve
    - E.g., Iowa 13-L1
  - The graphs below show each of the 18 original curves organized by modal family

Mortality Concepts



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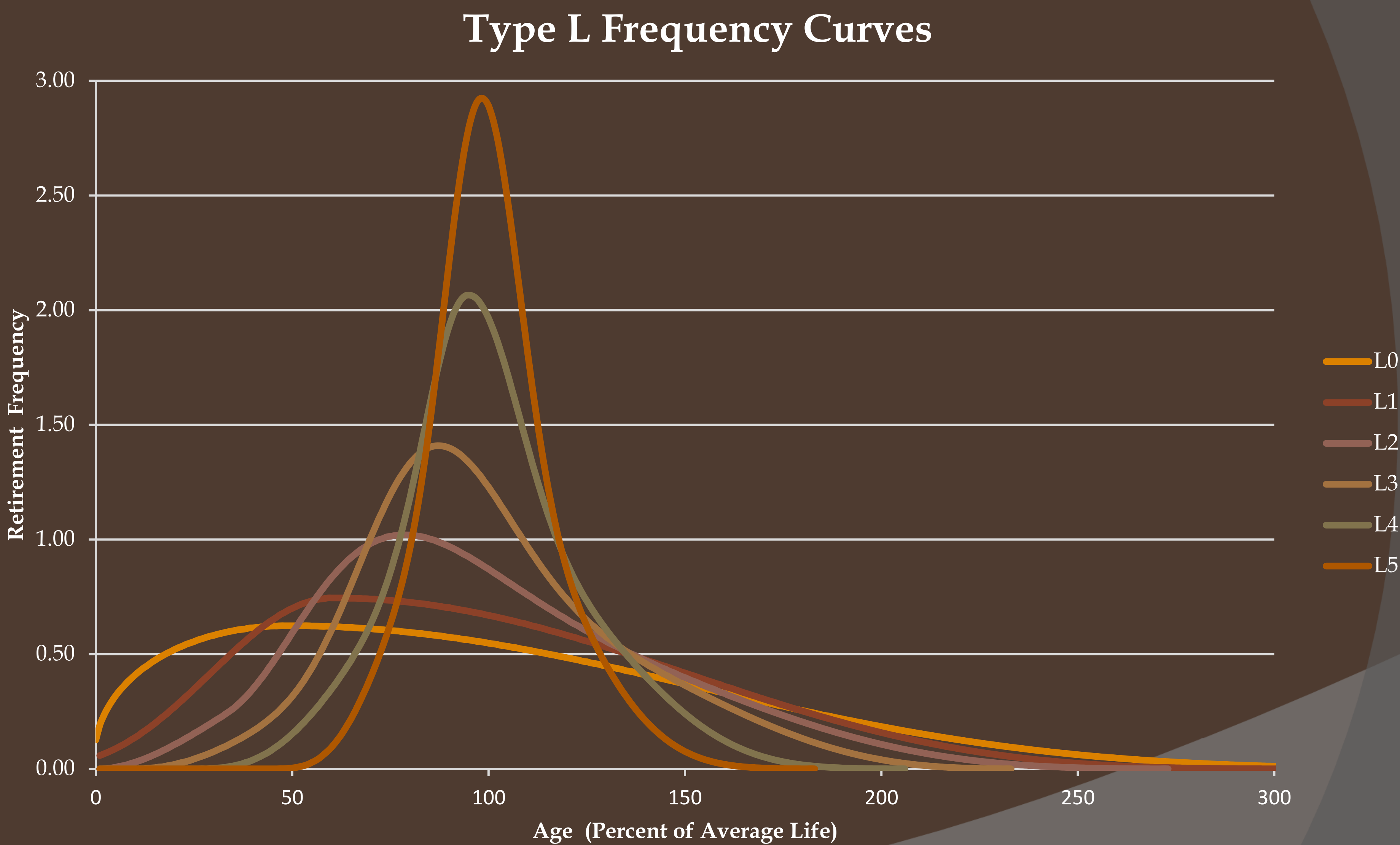

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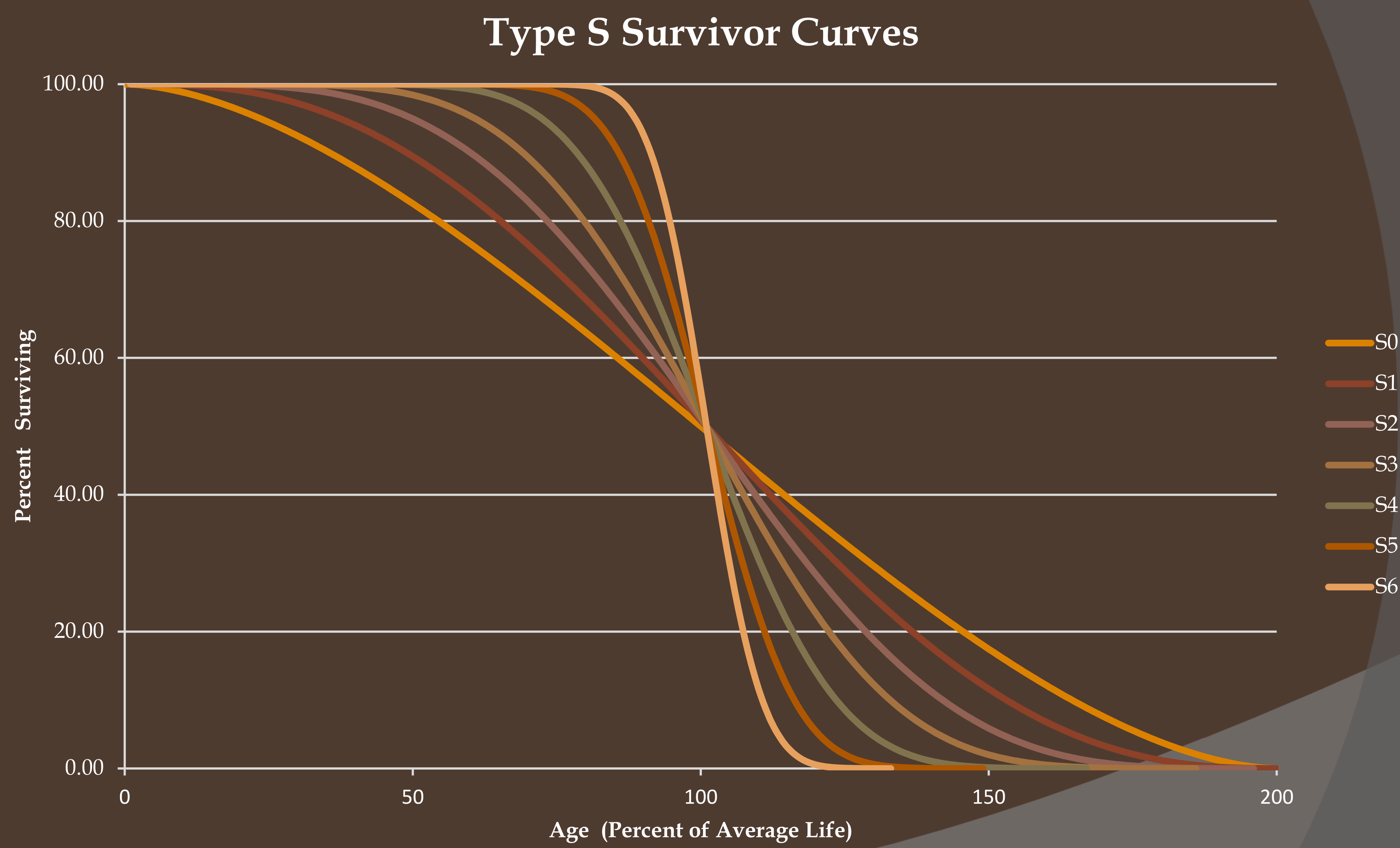

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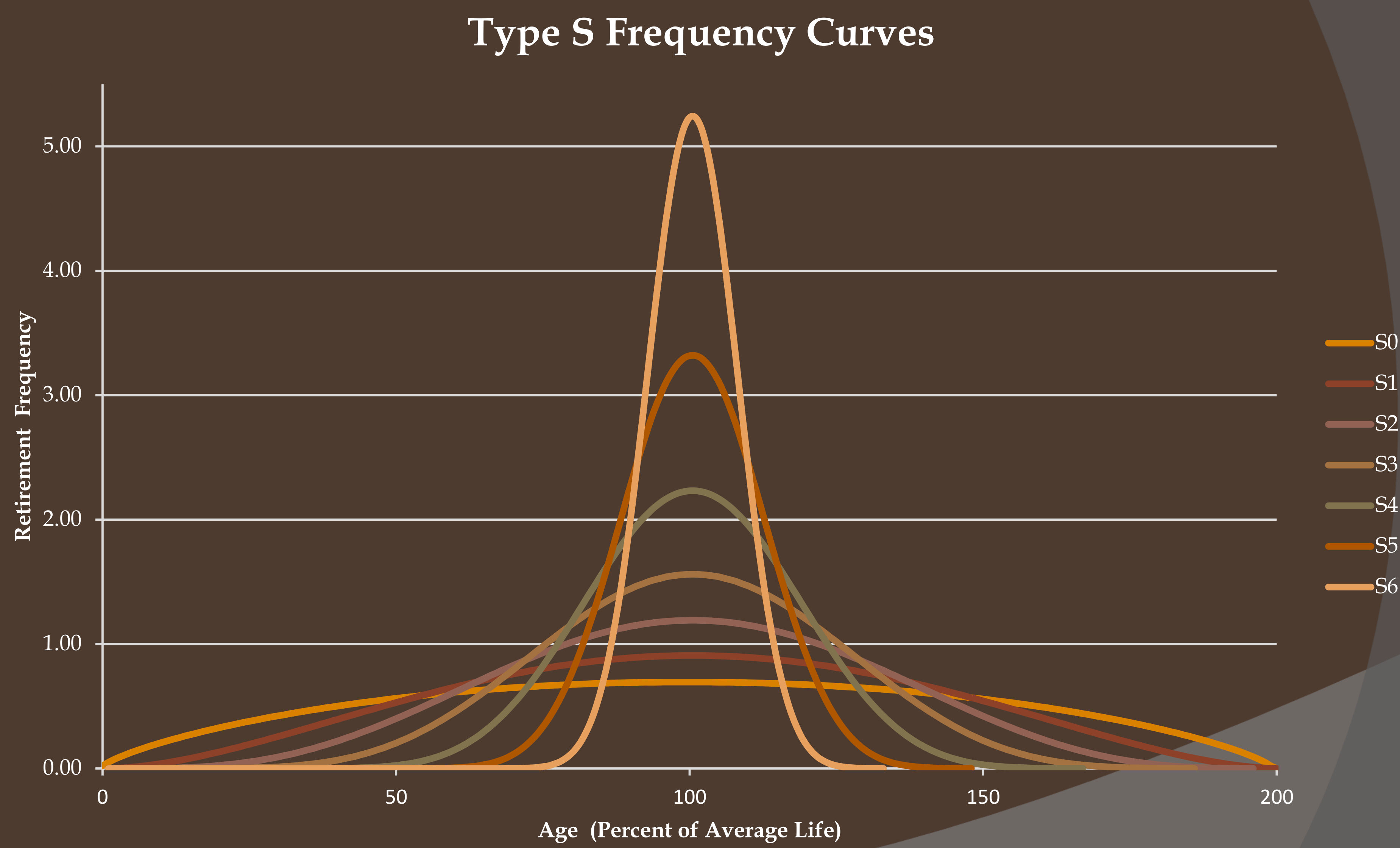

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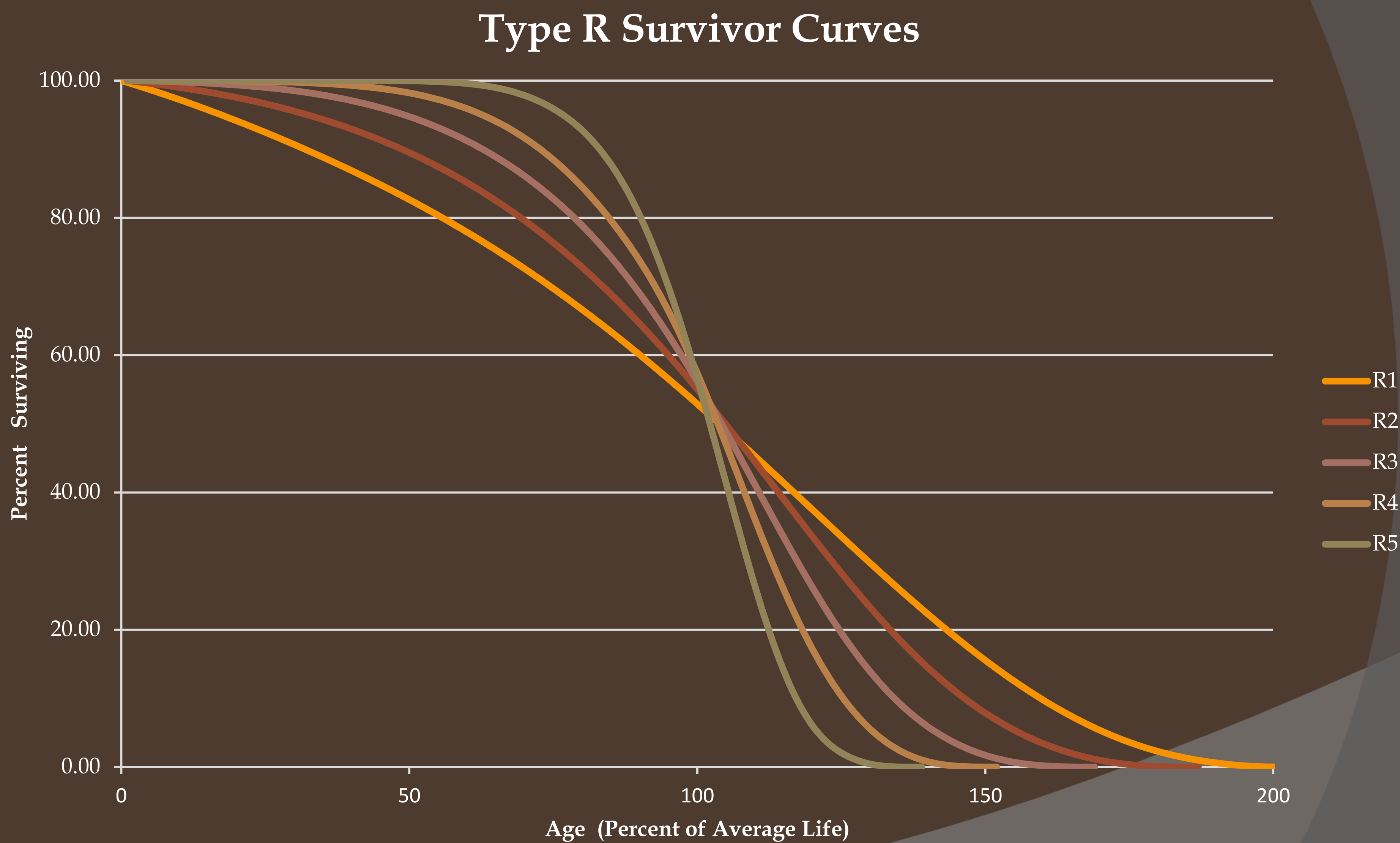
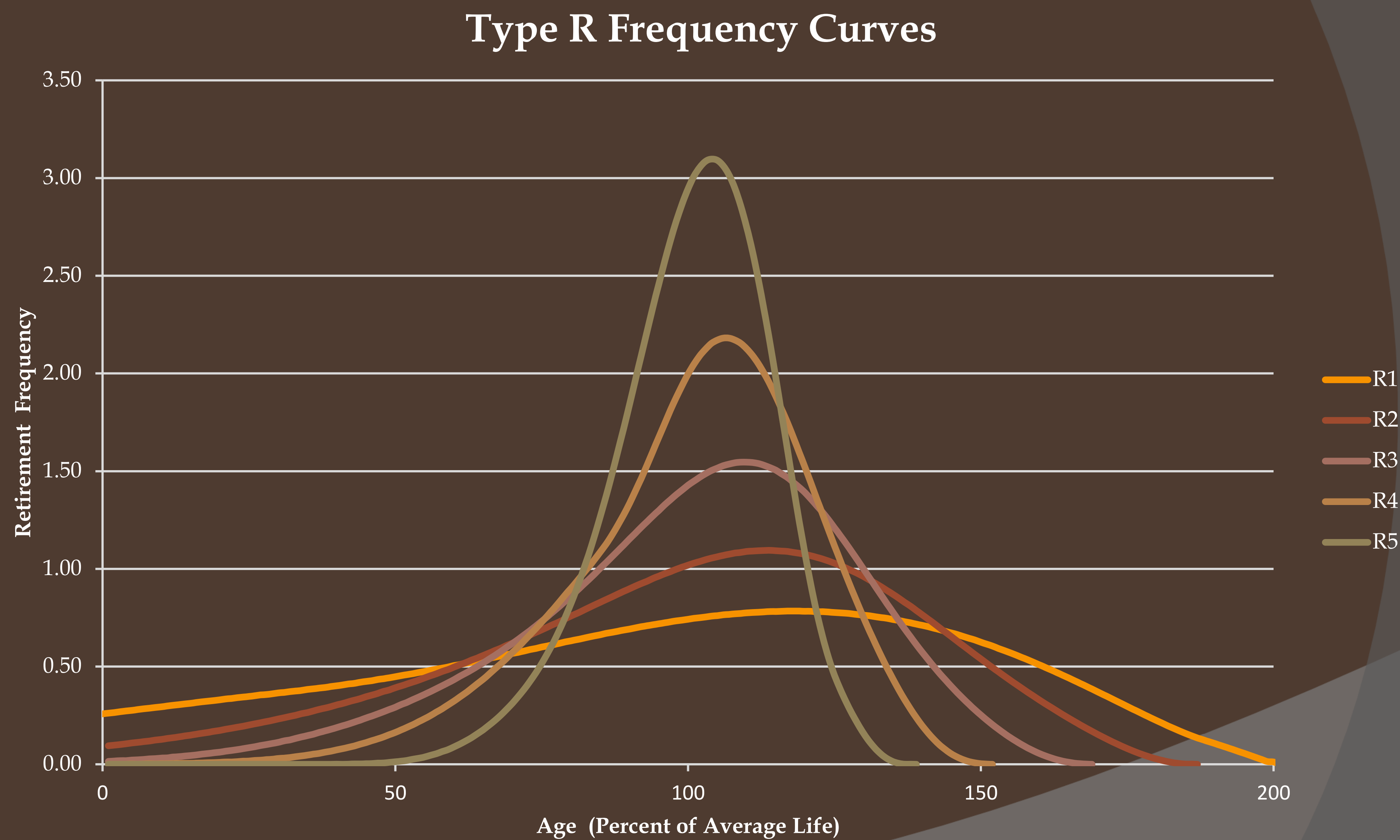


Mortality Concepts



Mortality Concepts

- Types of Lives
  - Average Life
  - Realized Life
  - Remaining Life
  - Probable Life

MORTALITY CONCEPTS

- Types of Lives
  - Average Life
    - The area under the survivor curve
    - Used in the denominator of the straight-line formula to calculate the annual accrual
    - Must have a complete survivor curve to calculate average life

Mortality Concepts

- Types of Lives
  - Realized Life
    - The average years of service experienced to date from the vintage's original installation
    - Like average life but taken at a point in time
    - Average life = realized life + unrealized life

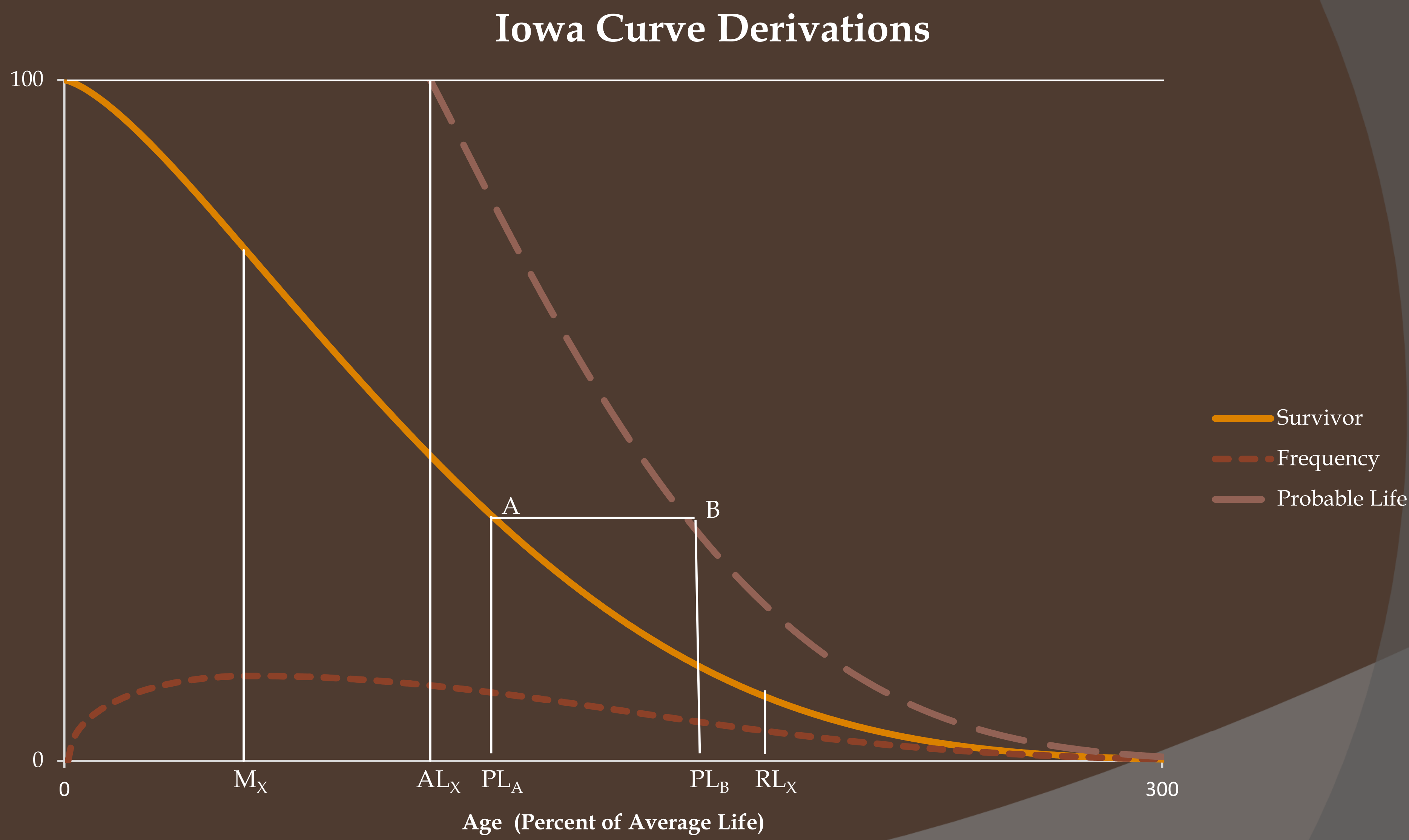
Mortality Concepts

- Types of Lives
  - Remaining Life
    - Represents future years of service expected from the surviving property
    - Calculated by taking the area under the future portion of the survivor curve divided by the percent surviving at that age
    - Used in the denominator of the RL method annual accrual formula

Mortality Concepts

- Types of Lives
  - Probable Life
    - The total life expectancy of the property surviving at any age
    - Probable life = remaining life + age
  - Each type of life may be calculated from the survivor curve
  - Each life is illustrated below

Mortality Concepts



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ACTUARIAL ANALYSIS

- Introduction
- The Retirement Rate Method
- Banding
- Curve Fitting

ACTUARIAL ANALYSIS

- Introduction
  - Actuaries study human mortality to assess risk and set insurance premiums
  - Study of human mortality is analogous to estimating service lives of industrial property groups
  - Most human mortality is a function of age
  - Review plant forces of retirement

Actuarial Analysis

- Introduction
  - Review Forces of Retirement ("Mortality")
    - Physical Factors
      - Wear, decay, and deterioration
      - Action of the elements and accidents
    - Functional Factors
      - Inadequacy
      - Obsolescence
      - Changes in the art and technology
      - Changes in demand
      - Regulatory requirements
      - Managerial Discretion
    - Contingent Factors
      - Casualties or disasters
      - Extraordinary obsolescence

Depreciation Systems, p. 276

Actuarial Analysis

- Introduction
  - Actuaries study historical data in order to forecast probable life
  - Depreciation analysts do the same
  - Continuing Property Records ("CPR")
    - Contains historical data of placements and retirements
    - This data is used in the retirement rate method

Actuarial Analysis

- The Retirement Rate Method
  - The best method used to calculate observed survivor curves
  - Observed survivor curves are rarely complete, so they must be fitted with Iowa curves
  - Historical data is put in a matrix format to calculate an observed life table ("OLT")
  - The exposure matrix, retirement matrix, and OLT are shown below

See Barreca SDP Presentation 2014

Actuarial Analysis

- The Exposure Matrix

Experience Years

Exposures at January 1 of Each Year (Dollars in 000's)

Placement Years	2008	2009	2010	2011	2012	2013	2014	2015	Total at Start of Age Interval	Age Interval
2003	261	245	228	211	**192**	173	152	131	131	11.5 - 12.5
2004	267	252	236	220	202	**184**	165	145	297	10.5 - 11.5
2005	304	291	277	263	248	232	**216**	198	536	9.5 - 10.5
2006	345	334	322	310	298	284	270	**255**	**847**	8.5 - 9.5
2007	367	357	347	335	324	312	299	286	1,201	7.5 - 8.5
2008	375	366	357	347	336	325	314	302	1,581	6.5 - 7.5
2009		377	366	356	346	336	327	319	1,986	5.5 - 6.5
2010			381	369	358	347	336	327	2,404	4.5 - 5.5
2011				386	372	359	346	334	2,559	3.5 - 4.5
2012					395	380	366	352	2,722	2.5 - 3.5
2013						401	385	370	2,866	1.5 - 2.5
2014							410	393	2,998	0.5 - 1.5
2015								416	3,141	0.0 - 0.5
Total	1919	2222	2514	2796	3070	3333	3586	3827	23,268	

Actuarial Analysis

- The Retirement Rate Method
  - The Exposure Matrix
    - Exposure is the depreciable property subject to retirement each year
    - Placement year ("vintage") – the year property was put in service
    - Experience year – refers to the accounting data for a particular calendar year
    - Half-year convention – assumes all units are installed uniformly during the year, thus installed in mid-year on average
    - Total for each age interval calculated using the "stair-step" method

Actuarial Analysis

- The Retirement Matrix

Experience Years

Retirments During the Year (Dollars in 000's)

Placement Years	2008	2009	2010	2011	2012	2013	2014	2015	Total During Age Interval	Age Interval
2003	16	17	18	19	19	20	21	23	23	11.5 - 12.5
2004	15	16	17	17	18	19	20	21	43	10.5 - 11.5
2005	13	14	14	15	16	17	17	18	59	9.5 - 10.5
2006	11	12	12	13	13	14	15	15	71	8.5 - 9.5
2007	10	11	11	12	12	13	13	14	82	7.5 - 8.5
2008	9	9	10	10	11	11	12	13	91	6.5 - 7.5
2009		11	10	10	9	9	9	8	95	5.5 - 6.5
2010			12	11	11	10	10	9	100	4.5 - 5.5
2011				14	13	13	12	11	93	3.5 - 4.5
2012					15	14	14	13	91	2.5 - 3.5
2013						16	15	14	93	1.5 - 2.5
2014							17	16	100	0.5 - 1.5
2015								18	112	0.0 - 0.5
Total	74	89	104	121	139	157	175	194	1,052	

Actuarial Analysis

- The Retirement Rate Method
  - The Retirement Matrix
    - The amounts retired during each year affect the amount of exposures at the beginning of the next year
    - Totals for each age interval calculated the same way as in the Exposure Matrix
    - There would be a separate matrix for sales, transfers, and adjusting entries, which would all affect the exposure amounts

ACTUARIAL ANALYSIS

- The Observed Life Table

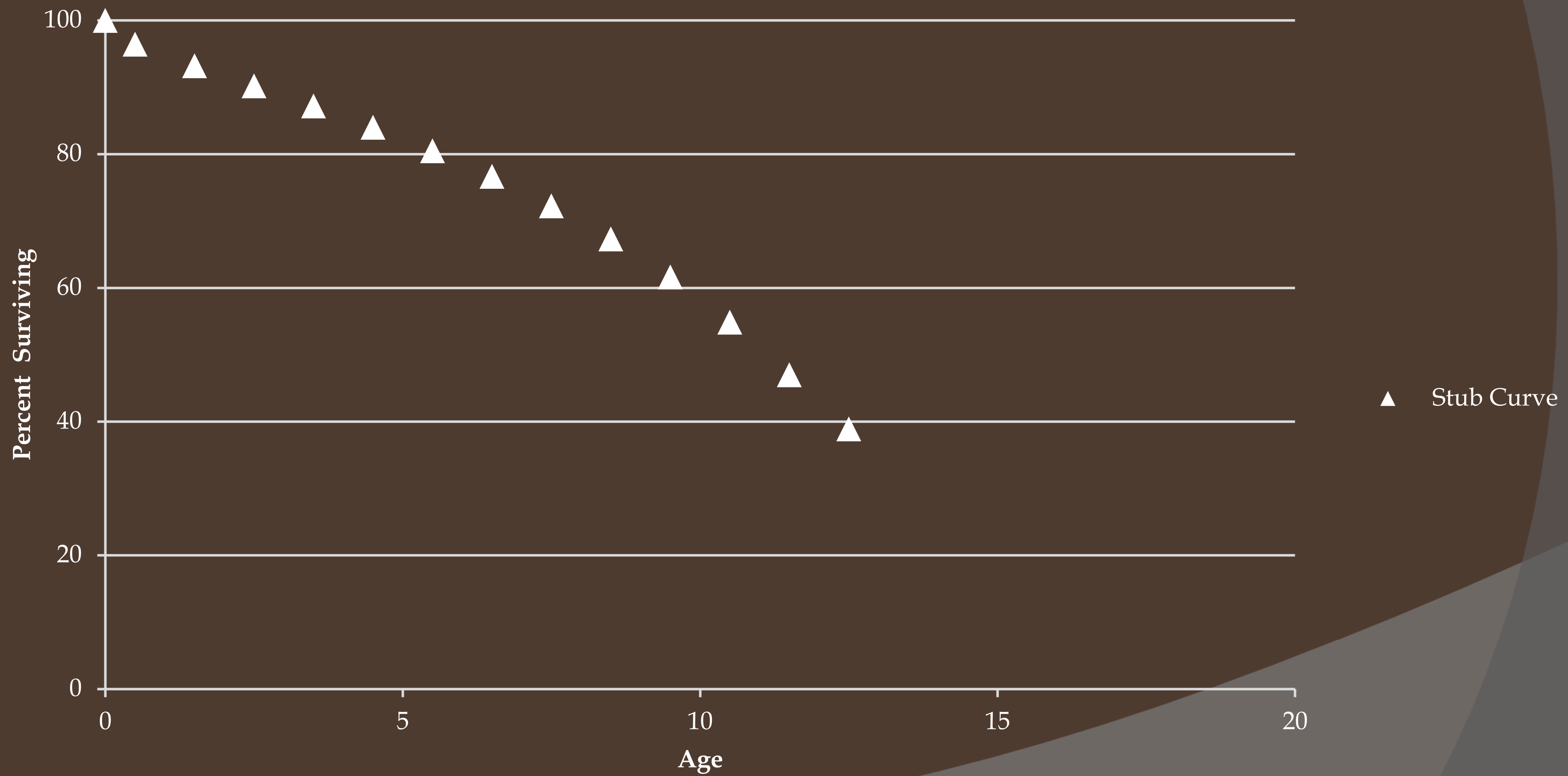
Age at Start of Interval A	Exposures at Start of Age Interval B	Retirements During Age Interval C	Retirement Ratio D = C / B	Survivor Ratio E = 1 - D	Percent Surviving at Start of Age Interval F
0.0	3,141	112	0.036	0.964	100.00
0.5	2,998	100	0.033	0.967	96.43
1.5	2,866	93	0.032	0.968	93.21
2.5	2,722	91	0.033	0.967	90.19
3.5	2,559	93	0.037	0.963	87.19
4.5	2,404	100	0.042	0.958	84.01
5.5	1,986	95	0.048	0.952	80.50
6.5	1,581	91	0.058	0.942	76.67
7.5	1,201	82	0.068	0.932	72.26
8.5	847	71	0.084	0.916	67.31
9.5	536	59	0.110	0.890	61.63
10.5	297	43	0.143	0.857	54.87
11.5	131	23	0.172	0.828	47.01
					38.91
Total	23,268	1,052			

Actuarial Analysis

- The Retirement Rate Method
  - The Observed Life Table
    - The totaled amounts for each age interval from both matrices form the exposure and retirement columns in the OLT
    - Retirement ratio – the probability that property surviving will be retired during the age interval
    - Survivor ratio – complement to the retirement ratio
    - Percents surviving in Column F are used to form the observed "stub" curve

ACTUARIAL ANALYSIS

- Original "Stub" Survivor Curve



ACTUARIAL ANALYSIS

- Banding
  - Forces of retirement are constantly changing
  - Banding helps isolate and measure the magnitude of these changes
  - Three primary benefits:
    - Increase the sample size
    - Smooth observed data
    - Identify trends
  - Two primary banding methods:
    - Placement band
    - Experience band

See Barreca SDP Presentation 2014

ACTUARIAL ANALYSIS

- Placement Bands

	Experience Years									
	Exposures at January 1 of Each Year (Dollars in 000's)									
Placement Years	2008	2009	2010	2011	2012	2013	2014	2015	Total at Start of Age Interval	Age Interval
2003	261	245	228	211	192	173	152	131		11.5 - 12.5
2004	267	252	236	220	202	184	165	145		10.5 - 11.5
2005	304	291	277	263	248	232	216	198	198	9.5 - 10.5
2006	345	334	322	310	298	284	270	255	471	8.5 - 9.5
2007	367	357	347	335	324	312	299	286	788	7.5 - 8.5
2008	375	366	357	347	336	325	314	302	1,133	6.5 - 7.5
2009		377	366	356	346	336	327	319	1,186	5.5 - 6.5
2010			381	369	358	347	336	327	1,237	4.5 - 5.5
2011				386	372	359	346	334	1,285	3.5 - 4.5
2012					395	380	366	352	1,331	2.5 - 3.5
2013						401	385	370	1,059	1.5 - 2.5
2014							410	393	733	0.5 - 1.5
2015								416	375	0.0 - 0.5
Total	1919	2222	2514	2796	3070	3333	3586	3827	9,796	

Actuarial Analysis

- Banding
  - Placement Bands
    - Isolate selected placement ("vintage") years
    - Used for comparing properties with a group with different physical characteristics
    - E.g. – in 2005 a utility started using a different chemical to treat transmission poles
    - Dilemma – placement bands yield shorter stub curbs for newer vintages, but newer vintages are better for forecasting

Actuarial Analysis

- Experience Bands

Experience Years

Exposures at January 1 of Each Year (Dollars in 000's)

Placement Years	2008	2009	2010	2011	2012	2013	2014	2015	Total at Start of Age Interval	Age Interval
2003	261	245	228	211	192	173	152	131		11.5 - 12.5
2004	267	252	236	220	202	184	165	145		10.5 - 11.5
2005	304	291	277	263	248	232	216	198	173	9.5 - 10.5
2006	345	334	322	310	298	284	270	255	376	8.5 - 9.5
2007	367	357	347	335	324	312	299	286	645	7.5 - 8.5
2008	375	366	357	347	336	325	314	302	752	6.5 - 7.5
2009		377	366	356	346	336	327	319	872	5.5 - 6.5
2010			381	369	358	347	336	327	959	4.5 - 5.5
2011				386	372	359	346	334	1,008	3.5 - 4.5
2012					395	380	366	352	1,039	2.5 - 3.5
2013						401	385	370	1,072	1.5 - 2.5
2014							410	393	1,121	0.5 - 1.5
2015								416	1,182	0.0 - 0.5
Total	1919	2222	2514	2796	3070	3333	3586	3827	9,199	

Actuarial Analysis

- Banding
  - Experience Bands
    - Isolates selected experience years
    - May be used to analyze the effects of an unusual environment event
    - E.g. – severe ice storm in 2013
    - Pro – Tend to yield the most complete stub curves for recent bands because they have the greatest numbers of vintages included
    - Con – result in more erratic dispersion patterns making curve fitting more difficult

Actuarial Analysis

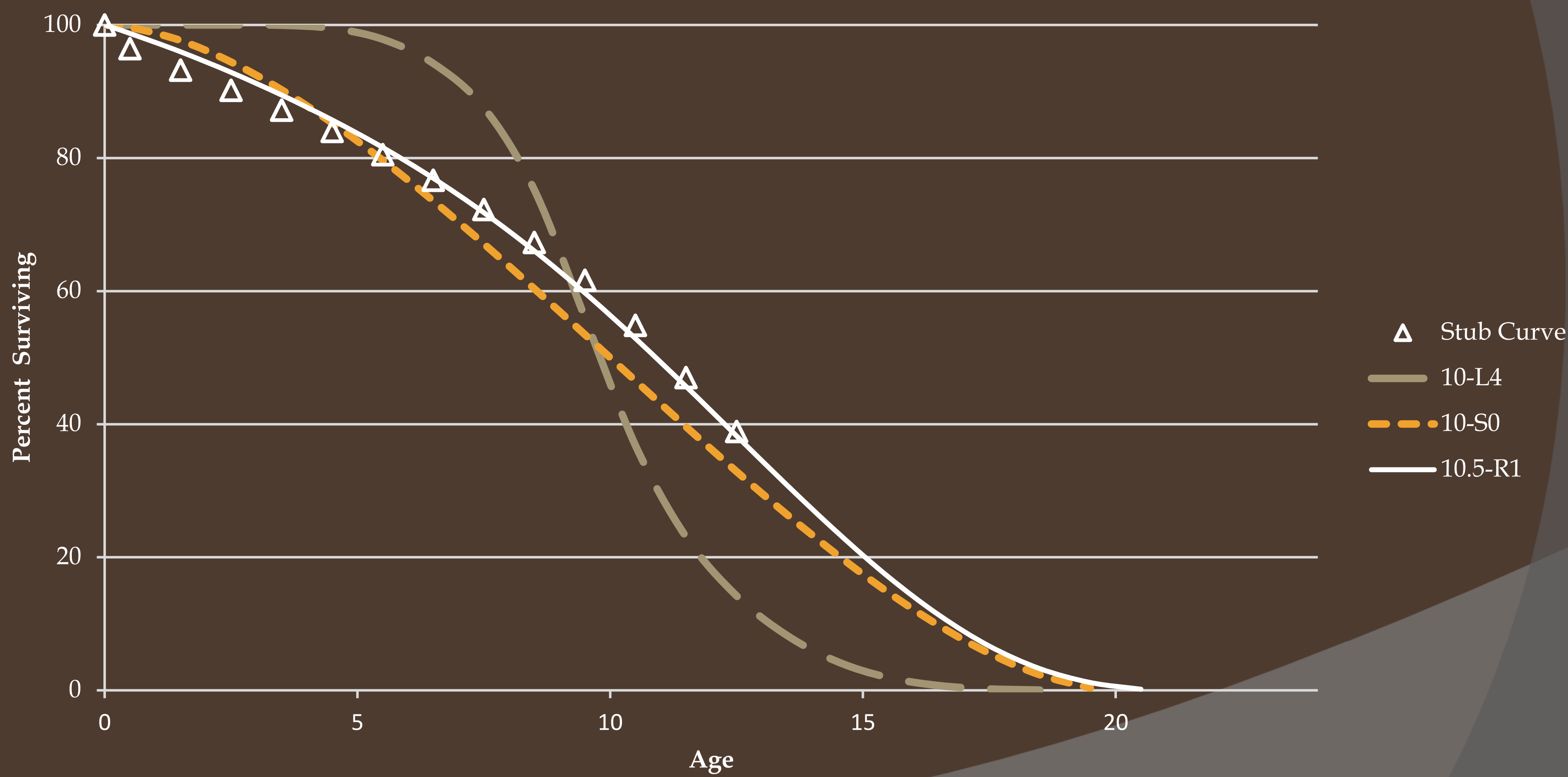
- Banding
  - Conclusion
    - Analysts use combinations of placement and experience bands
    - Analysts must ultimately use professional judgment in determining the type of band and band width
    - Regardless of band choice, observed survivor curves rarely reach zero percent
    - Curve fitting using standardized curves is necessary to complete the curve

Actuarial Analysis

- Curve Fitting
  - Generalized survivor curves (mainly Iowa curves) are used to fit observed stub curves
  - Necessary to get smooth, complete survivor curves in order to calculate average life
  - May be done visually or mathematically

MORTALITY CONCEPTS

- Visual Curve Fitting



Actuarial Analysis

- Curve Fitting
  - Visual Curve Fitting
    - Analyst makes a judgment about the best fitting Iowa curve by examining plotted data
    - In the example above, visual fitting is sufficient to see that the 10.5-R1 is the best fit
    - Is more subjective than mathematical fitting

Actuarial Analysis

- Curve Fitting
  - Mathematical Curve Fitting
    - Uses sum of least squares method to calculate the best fitting curve
    - Less subjective than visual fitting
    - Blind reliance may lead to poor estimates
    - Analysts should use mathematical fitting but check the results visually and employ judgment to make sure the estimate is sound

Actuarial Analysis

- Mathematical Curve Fitting

Age Interval	Stub Curve	Iowa Curves 10-L4	Iowa Curves 10-S0	Iowa Curves 10.5-R1	Squared Differences 10-L4	Squared Differences 10-S0	Squared Differences 10.5-R1
0.0	100.0	100.0	100.0	100.0	0.0	0.0	0.0
0.5	96.4	100.0	99.7	98.7	12.7	10.3	5.3
1.5	93.2	100.0	97.7	96.0	46.1	19.8	7.6
2.5	90.2	100.0	94.4	92.9	96.2	18.0	7.2
3.5	87.2	100.0	90.2	89.5	162.9	9.3	5.2
4.5	84.0	99.5	85.3	85.7	239.9	1.6	2.9
5.5	80.5	97.9	79.7	81.6	301.1	0.7	1.2
6.5	76.7	94.2	73.6	77.0	308.5	9.5	0.1
7.5	72.3	87.6	67.1	71.8	235.2	26.5	0.2
8.5	67.3	75.2	60.4	66.1	62.7	48.2	1.6
9.5	61.6	56.0	53.5	59.7	31.4	66.6	3.6
10.5	54.9	36.8	46.5	52.9	325.4	69.6	3.9
11.5	47.0	23.1	39.6	45.7	572.6	54.4	1.8
12.5	38.9	14.2	32.9	38.2	609.6	36.2	0.4
SUM					**3004.2**	**371.0**	**41.0**

Outline

- Introduction
- Accounting and Computations
- Depreciation Systems
- Mortality Concepts
- Actuarial Analysis
- Simulated Plant Record Model
- Removal Cost and Salvage
- Ratemaking Issues

Simulated Plant Record Model

- Introduction
  - Actuarial analysis requires aged data
  - What if you don’t have aged data?
  - Simulated Plant Record (“SPR”) model is used to simulate the retirement pattern for each vintage
  - 1922 – Cyrus Hill developed the principles used in the SPR model today
  - 1947 – Alex Bauhan expanded SPR and developed several criterion to measure the results of the analysis

The following example is from Jensen SDP Presentation 2014

Simulated Plant Record Model

- Aged Data

		End of Year Balances ($)								
Vintage	Installations	1997	1999	2001	2003	2005	2007	2009	2011	2013
1997	220	220	220	220	213	194	152	95	19	0
			250	250	248	235	198	143	31	4
1999	270		270	270	270	262	238	186	57	9
				285	285	282	268	225	91	26
2001	300			300	300	300	291	264	145	42
					320	320	317	301	241	103
2003	350				350	350	350	340	284	157
						375	375	371	325	219
2005	390					390	390	390	362	286
							405	405	392	344
2007	450						450	450	441	416
								480	480	478
2009	500							500	500	500
									580	580
2011	670								670	670
										790
2013	750									750
Balance		220	740	1325	1986	2708	3434	4150	4618	5374

Simulated Plant Record Model

- Unaged Data

		End of Year Balances ($)								
Vintage	Installations	1997	1999	2001	2003	2005	2007	2009	2011	2013
1997	220									
1999	270									
2001	300									
2003	350									
2005	390									
2007	450									
2009	500									
2011	670									
2013	750									
Balance		220	740	1325	1986	2708	3434	4150	4618	5374

SIMULATED PLANT RECORD MODEL

- SPR Using 10-S3: 2009 Test Year

Age Interval	Vintage Year	Installations	10-S3 % Surviving	Sim. Bal. 2009
12.5	1997	220	16	35
11.5	1998	250	28	69
10.5	1999	270	42	114
9.5	2000	285	58	165
8.5	2001	300	72	217
7.5	2002	320	84	269
6.5	2003	350	92	323
5.5	2004	375	97	363
4.5	2005	390	99	386
3.5	2006	405	100	404
2.5	2007	450	100	450
1.5	2008	480	100	480
0.5	2009	500	100	500
		Total Simulated Balance		3,775
		Total Actual Balance		4,150
		Difference		(375)

SIMULATED PLANT RECORD MODEL

- SPR Using 12-S3: 2009 Test Year

Age Interval	Vintage Year	Installations	12-S3 % Surviving	Sim. Bal. 2009
12.5	1997	220	43	95
11.5	1998	250	57	143
10.5	1999	270	69	186
9.5	2000	285	79	225
8.5	2001	300	88	264
7.5	2002	320	94	301
6.5	2003	350	97	340
5.5	2004	375	99	371
4.5	2005	390	100	390
3.5	2006	405	100	405
2.5	2007	450	100	450
1.5	2008	480	100	480
0.5	2009	500	100	500
		Total Simulated Balance		4,150
		Total Actual Balance		4,150
		Difference		0

Simulated Plant Record Model

- Recap of 2009 Test Year
  - We first chose Iowa curve 10-S3 to start
  - The simulated balance was less than the actual balance
  - So we chose a longer curve (12-S3) and it resulted in a perfect fit
  - SPR, however, should never be tested on one year (there is always a perfect fit for any one year)

Simulated Plant Record Model

SPR Using Iowa Curve 12-S3: 2009, 2011, 2013

Vintage	Insts.	% Surv.	2009	% Surv.	2011	% Surv.	2013
1997	220	43	95	21	46	6	13
1998	250	57	143	31	78	12	30
1999	270	69	186	43	116	21	57
2000	285	79	225	57	162	31	88
2001	300	88	264	69	207	43	129
2002	320	94	301	79	253	57	182
2003	350	97	340	88	308	69	242
2004	375	99	371	94	353	79	296
2005	390	100	390	97	378	88	343
2006	405	100	405	99	401	94	381
2007	450	100	450	100	450	97	437
2008	480	100	480	100	480	99	475
2009	500	100	500	100	500	100	500
2010	580			100	580	100	580
2011	670			100	670	100	670
2012	790					100	790
2013	750					100	750
Simulated Balances			$ 4,150		$ 4,982		$ 5,963
Actual Balances			4,150		4,618		5,374
Difference			0		364		589
Difference Squared			0		132,496		346,921

SSD = 479,417 **MSD = 159,806** **VMSD = 400**

CI = Average Actual Bal / VMSD = 4,714 / 400 = 12

IV = 1000 / CI = 85

Simulated Plant Record Model

SPR Using Iowa Curve 10-S3: 2009, 2011, 2013

Vintage	Insts.	% Surv.	2009	% Surv.	2011	% Surv.	2013
1997	220	16	35	3	7	0	0
1998	250	28	70	8	20	1	3
1999	270	42	113	16	43	3	8
2000	285	58	165	28	80	8	23
2001	300	72	216	42	126	16	48
2002	320	84	269	58	186	28	90
2003	350	92	322	72	252	42	147
2004	375	97	364	84	315	58	218
2005	390	99	386	92	359	72	281
2006	405	100	405	97	393	84	340
2007	450	100	450	99	446	92	414
2008	480	100	480	100	480	97	466
2009	500	100	500	100	500	99	495
2010	580			100	580	100	580
2011	670			100	670	100	670
2012	790					100	790
2013	750					100	750
Simulated Balances			$ 3,775		$ 4,457		$ 5,323
Actual Balances			4,150		4,618		5,374
Difference			(375)		(161)		(51)
Difference Squared			140,625		25,921		2,601

SSD = 169,147 **MSD = 56,382** **√MSD = 237**

CI = Average Actual Bal / √MSD = 4,714 / 237 = 20 **IV = 1000 / CI = 50**

Simulated Plant Record Model

- Conformance Index Scale

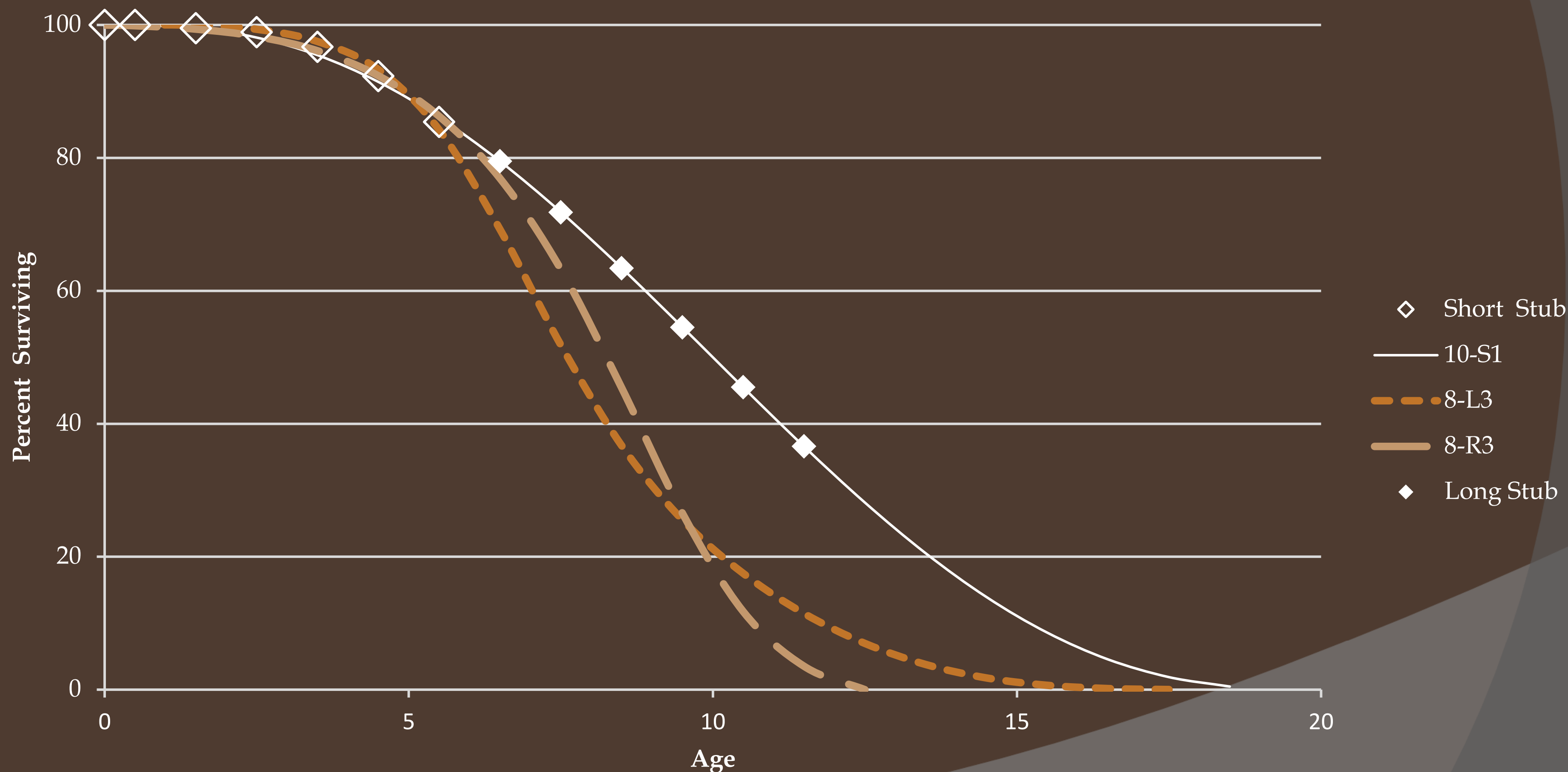
CI	Value
> 75	Excellent
50 – 75	Good
25 – 50	Fair
< 25	Poor

Simulated Plant Record Model

- Retirement Experience Index
  - Measures the maturity of the account
  - Calculated by dividing the balance from the oldest vintage by the installation cost
  - Higher retirement experience provides for more accurate curve fitting
  - If stub curves are too short, there may appear to be many Iowa curves that could provide a good fit

Simulated Plant Record Model

- REI Demonstration



Simulated Plant Record Model

- REI Scale

REI	Value
> 75%	Excellent
50% – 75%	Good
33% – 50%	Fair
17% – 33%	Poor
0% – 17%	Valueless

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SALVAGE AND REMOVAL COST

- Introduction
  - Gross Salvage – the dollar amount received for property retired if sold
  - Cost of removal – the cost of demolishing, dismantling, or otherwise removing plant
  - Net Salvage
    - Gross Salvage less removal cost
    - Review basic straight-line formula
      - $$\text{Annual Accrual} = \frac{\text{Original Cost} - \text{Net Salvage}}{\text{Average Service Life}}$$

Salvage and Removal Cost

- Introduction
  - Net Salvage
    - Review NS% formula

$$\text{Net Salvage \%} = \frac{(\text{Gross Salvage \$} - \text{Removal Cost \$})}{\text{Retirement \$}}$$

- $$\text{Avg. Life Rate} = \frac{(100\% - \text{Avg. NS\%})}{\text{Avg. Service Life}}$$

- $$\text{Avg. RL Rate} = \frac{(100\% - \text{Future NS\%})}{\text{Avg. Remaining Life}}$$

Salvage and Removal Cost

- Introduction
  - Net Salvage
    - Allocation Concept
      - Property ownership includes the responsibility of the asset's ultimate removal
      - If current uses benefit from an asset's use, they should pay their pro rata share of the costs of removal

Salvage and Removal Cost

- Net Salvage
  - Lifespan / Production Plant
    - Terminal Net Salvage
      - Demolition Studies
        - Contingency costs
        - Escalation rates
    - Interim Net Salvage
  - Mass Property
    - Historical salvage rate analysis used to identify trends and project future net salvage
    - Gradualism

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Ratemaking Issues

- Intergenerational Equity
  - Climate Policies
  - Replacement programs
- ALG vs ELG
- Practical Impacts
  - Rate shock mitigation
  - Cash flow
  - Settlement leverage

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QUESTIONS AND DISCUSSION

NASUCA

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