Overview of Escapement Goal Policy and Processes

A Presentation to the Alaska Board of Fisheries
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RC 19

Roadmap for Presentation

- Review policy framework and processes for escapement goals in Alaska
- Overview of current escapement goal types by region and species
- Concepts and theory of salmon production
- Why and how do escapement goals change?
- How does declining productivity affect escapement goals?
- Why hasn't ADF&G used SETs?

Providing for Sustained Yield

Constitution:

Article VIII, Sec(4). Fish, forests, wildlife, grasslands, and all other replenishable resources belonging to the State shall be utilized, developed, and maintained on **the sustained yield principle,** subject to preferences among beneficial uses.

Statute:

AS 16.05.020(2). The commissioner (of the Department of Fish and Game) shall manage, protect, maintain, improve and extend the fish, game and aquatic plant resources of the state in the interest of the economy and general well-being of the state.

Providing for Sustained Yield

Policies and regulations

- Policy for management of mixed stock fisheries, 5 AAC 39.220
- Policy for the management of sustainable salmon fisheries, 5 AAC 39.222
- Policy for statewide salmon escapement goals, 5 AAC 39.223
- Salmon Management Plans

Escapement Goal Policy

(b) Department responsibilities:

(1) Document salmon escapement goals

(2-5) Establish BEG's, SEG's and SET's for salmon stocks or population aggregates

(6) Review goals on the Board of Fisheries cycle

(7) Prepare scientific analyses for goals

(8) Notify public when goals are established or modified

(9) Report allocative impacts of goals to the Board of Fisheries

Escapement Goal Policy

(c) The Board of Fisheries responsibilities:

(1) Take regulatory action to address allocative issues

(2) Review goals and consider establishing Optimal Escapement Goals or in-river run goals.

Sustainable Salmon Fisheries Policy

(c) (2) Fisheries managed for escapement necessary to conserve and sustain salmon production

(A) Escapement monitoring appropriate to scale, intensity and importance of stock

(B) Goals established in a manner consistent with sustained yield; to the extent possible, fisheries managed for maximum sustained yield

(C) Goal ranges to consider uncertainty and environmental variability

(D) Escapement managed to maintain genetic and phenotypic characteristics

(F) Escapement and management decisions should protect non-target stocks

(G) Ecosystem function considered in escapement goal setting

Definition of Terms

- Stock, escapement, run, return, yield
- Sustained yield, maximum sustained yield, and optimum sustained yield
- Stock of concern

Types of Escapement Goals

- Biological Escapement Goal (BEG)
- Sustainable Escapement Goal (SEG)
- Optimal Escapement Goal (OEG)
- Sustained Escapement Threshold (SET)

Biological Escapement Goal (BEG)

- Determined by the Department
- Escapement with greatest potential for maximum sustained yield (MSY)
- Based on best available biological information
- Scientifically defensible
- Always a range
- Department will maintain evenly distributed escapements within the bounds

Sustainable Escapement Goal (SEG)

- Determined by the Department
- Escapement known to provide for sustained yields over a five to ten year period
- Used where a BEG cannot be estimated
- Based on best available biological information
- Scientifically defensible
- Can be a range or a bound
- Department will maintain escapements within the bounds of a range or above a lower bound

Optimal Escapement Goal (OEG)

- Set in regulation by the Board of Fisheries
- Considers biological and allocative factors
- Can differ from BEG or SEG, but must be sustainable
- May be expressed as a range
- Department will maintain evenly distributed escapements within the bounds of the range

Sustainable Escapement Threshold (SET)

- Established as needed by the Department in consultation with the Board of Fisheries
- Escapement level, below which sustainability is jeopardized
- Lower than the lower bound of BEG or SEG
- Can be based on lower levels of escapement that consistently sustain themselves

ADF&G Escapement Goal Development Process

Regional Escapement Goal Review Team

- Create work assignments
- Review regional/area escapement goals
- Draft stock escapement goal analyses
- Draft escapement goal report

ADF&G staff and public review

Approval of escapement goal recommendations by Regional Supervisor

Presentation of recommendations to Board of Fisheries

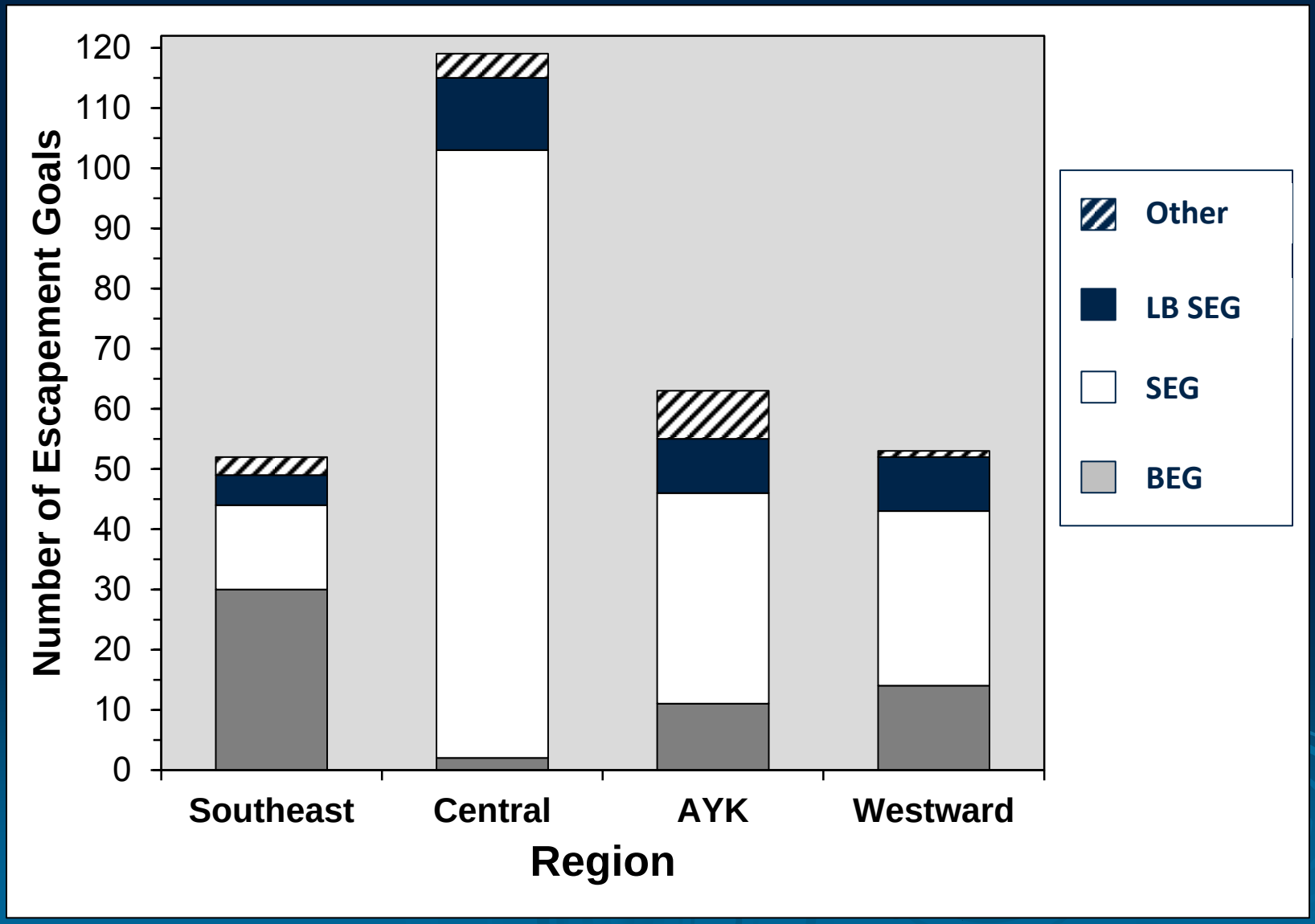
Board may adopt OEG's or in-river run goals based on biological or allocative factors

Formal adoption by Division Directors

Current Escapement Goal Types

Escapement Goal Types by Region

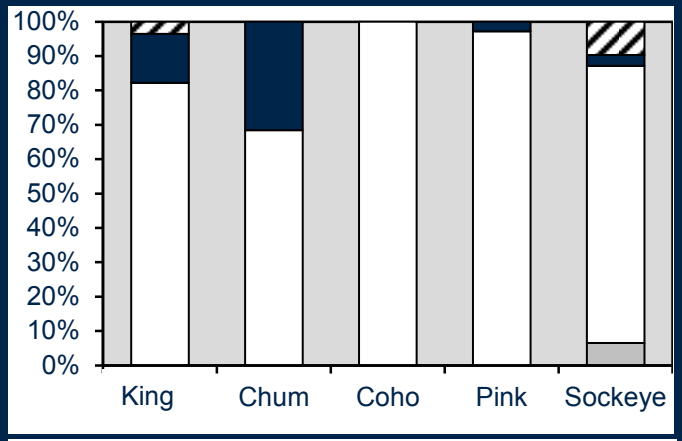
All species



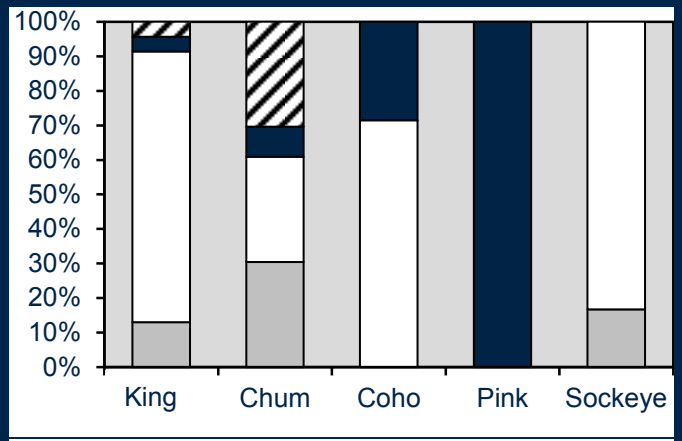
Regional Escapement Goals

By species

Central
N = 119

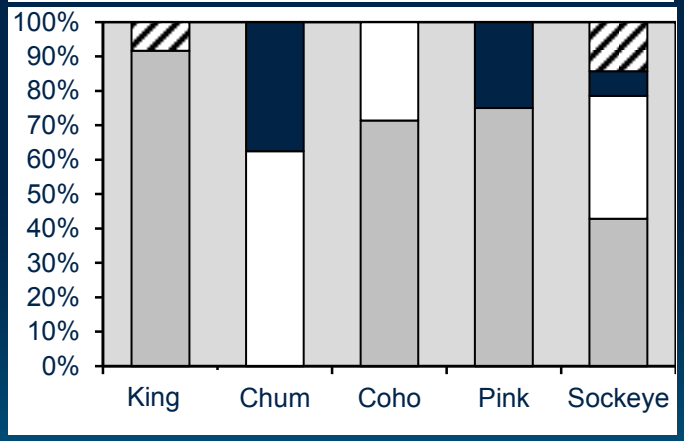


AYK
N = 63

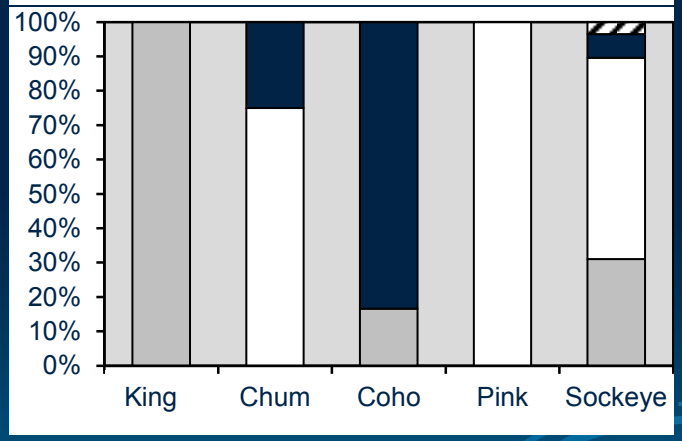


Other
LB SEG
SEG
BEG

Southeast
N = 52



Westward
N = 53



Success Meeting Escapement Goals 2010-2016

Current number of goals – 287

Goals achieved – 77% overall

King	56%
Chum	80%
Coho	86%
Pink	79%
Sockeye	85%

Understanding Salmon Production

Terms for Speaking about Salmon Production

Return = Adult salmon produced from a single brood year escapement

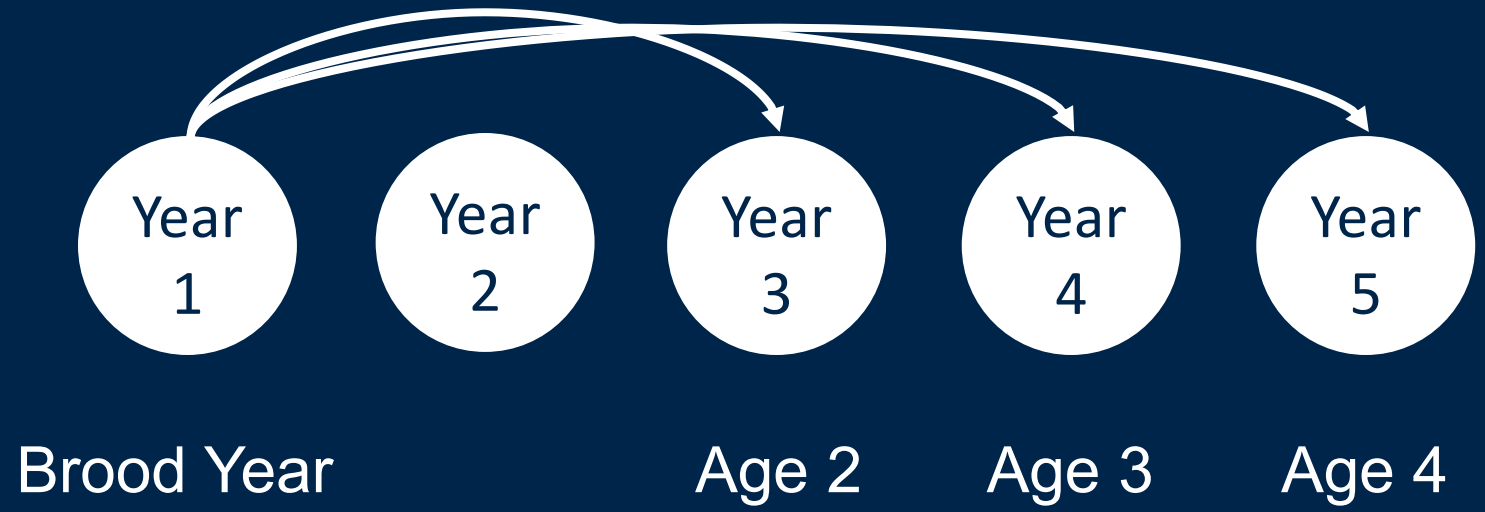
Run = Adult salmon returning to the vicinity of the natal stream in a calendar year

Escapement = Count of spawners in a year (or index)

Yield = Adult salmon produced in excess of escapement from a single brood year

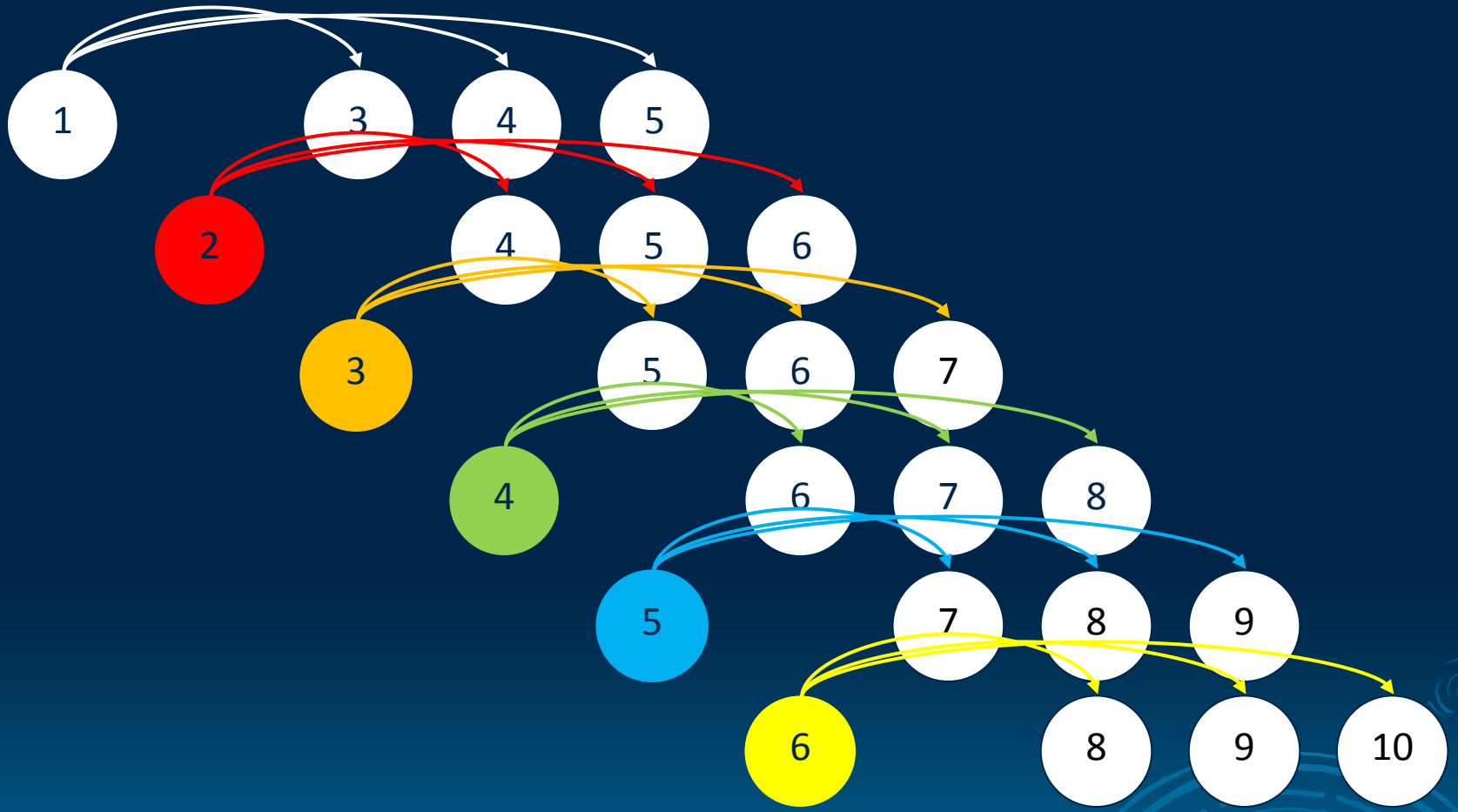
Understanding Age Structure

Simple model



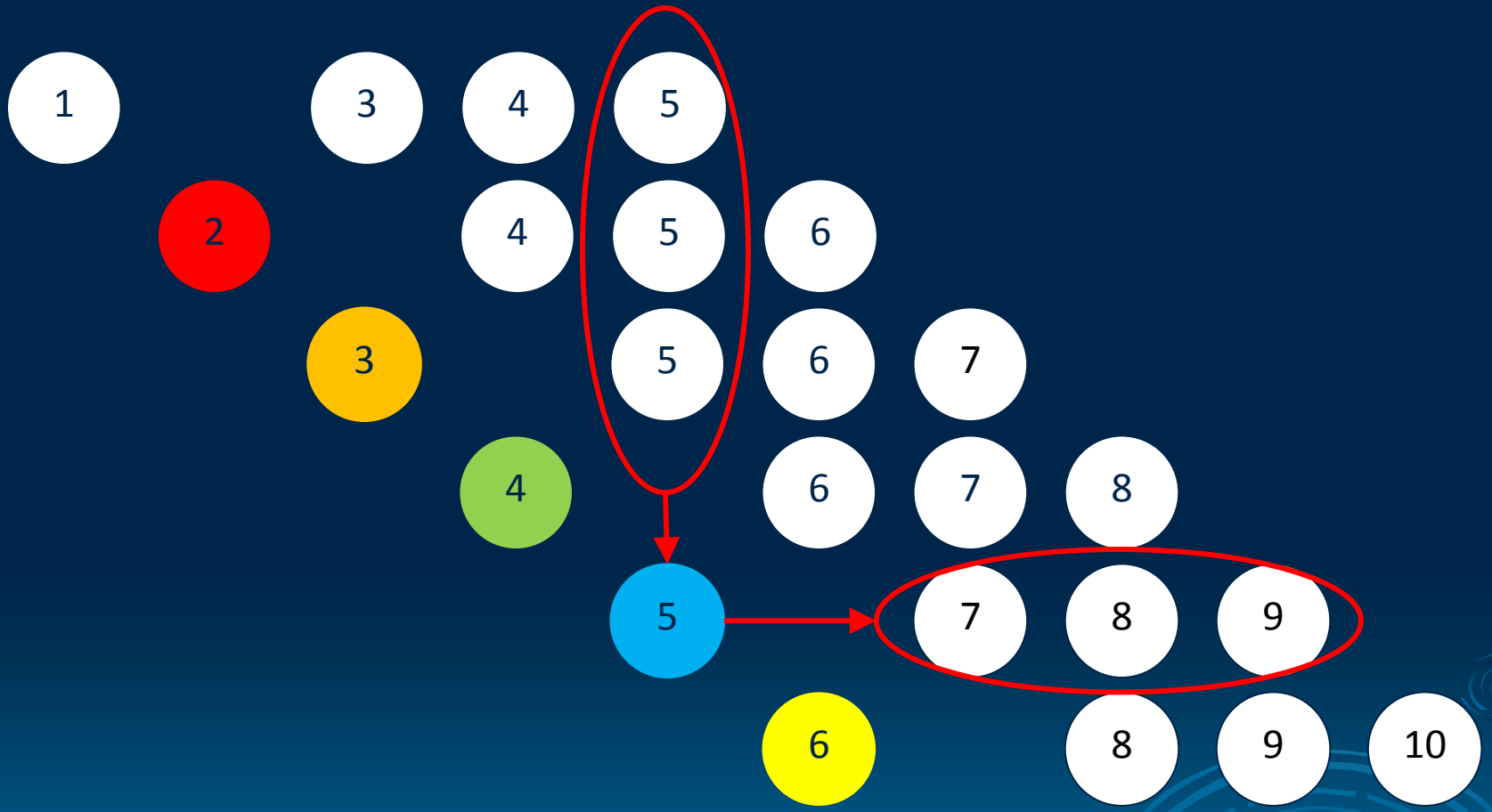
Understanding Age Structure

Simple model



Understanding Age Structure

Simple model

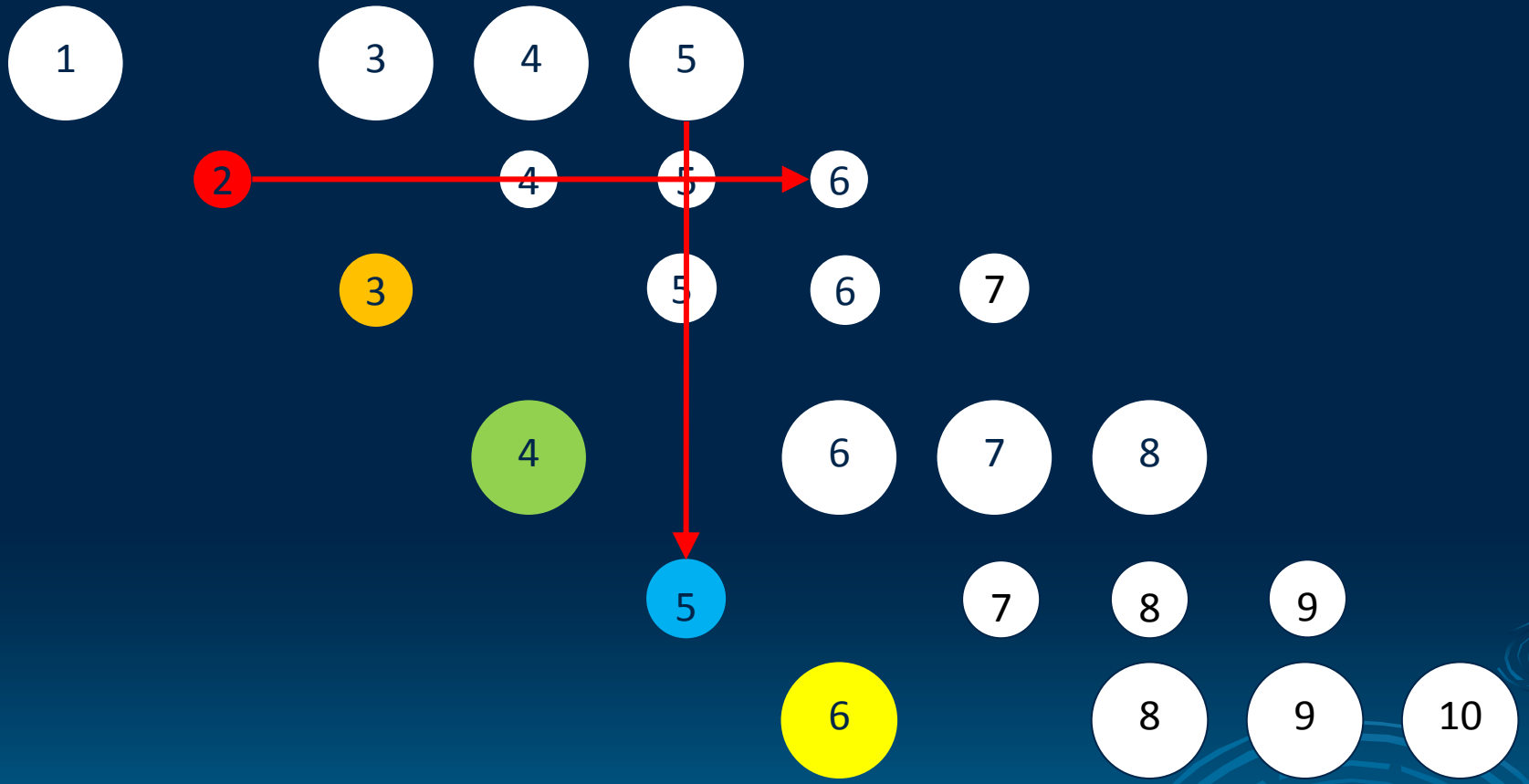


The “run” in year 5 comes from fish spawned in years 1, 2 & 3

The “return” from year 5 contributes to years 7, 8 & 9

Understanding Age Structure

Simple model

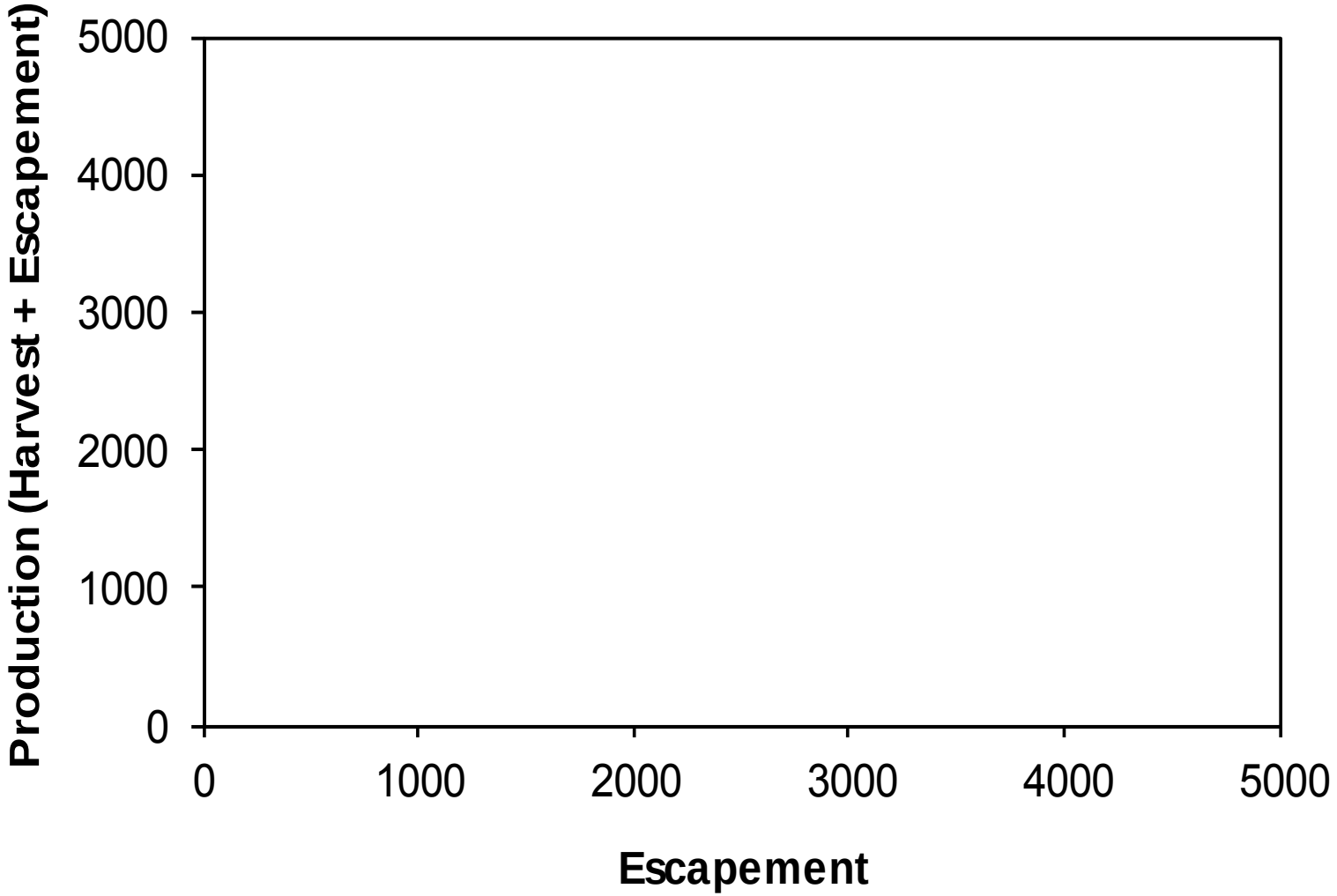


Spreading the returns across 3 years reduces the influence of each contributing brood year on the resulting run

Theory of Salmon Production

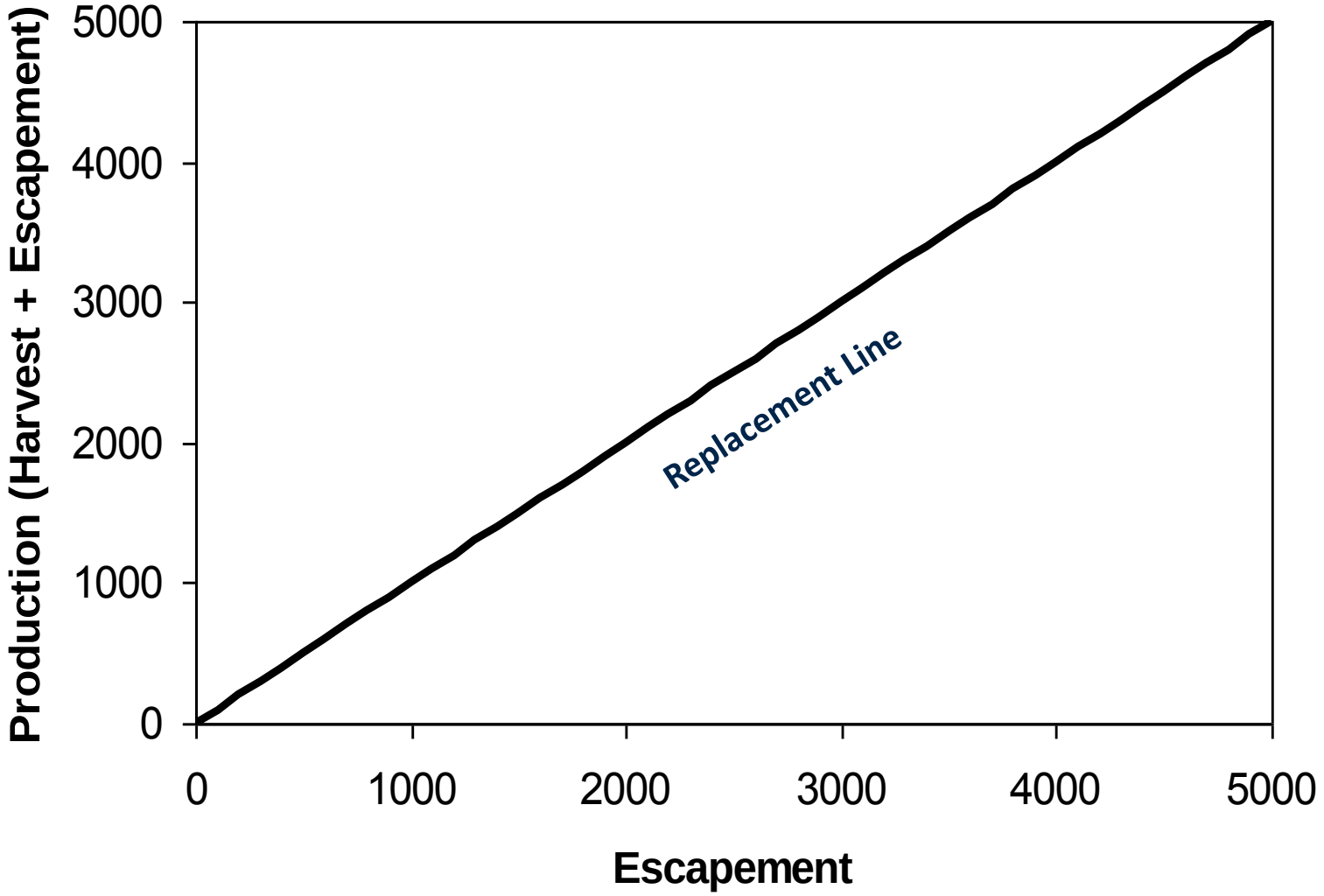
Theory of Salmon Production

Escapement and the subsequent production can be plotted on a graph like this…



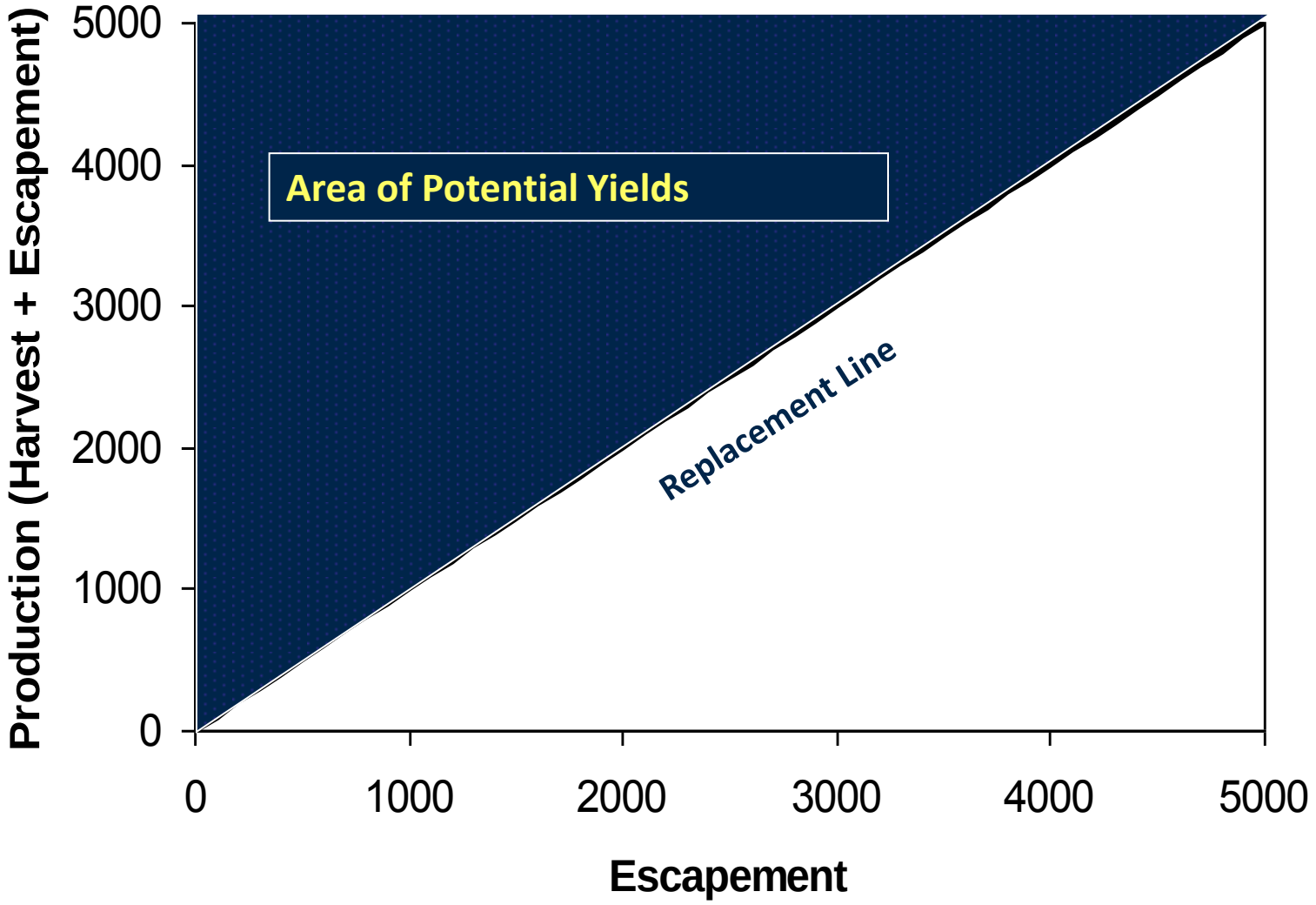
Theory of Salmon Production

…with a **Replacement Line** where escapement = production (i.e. no yields).



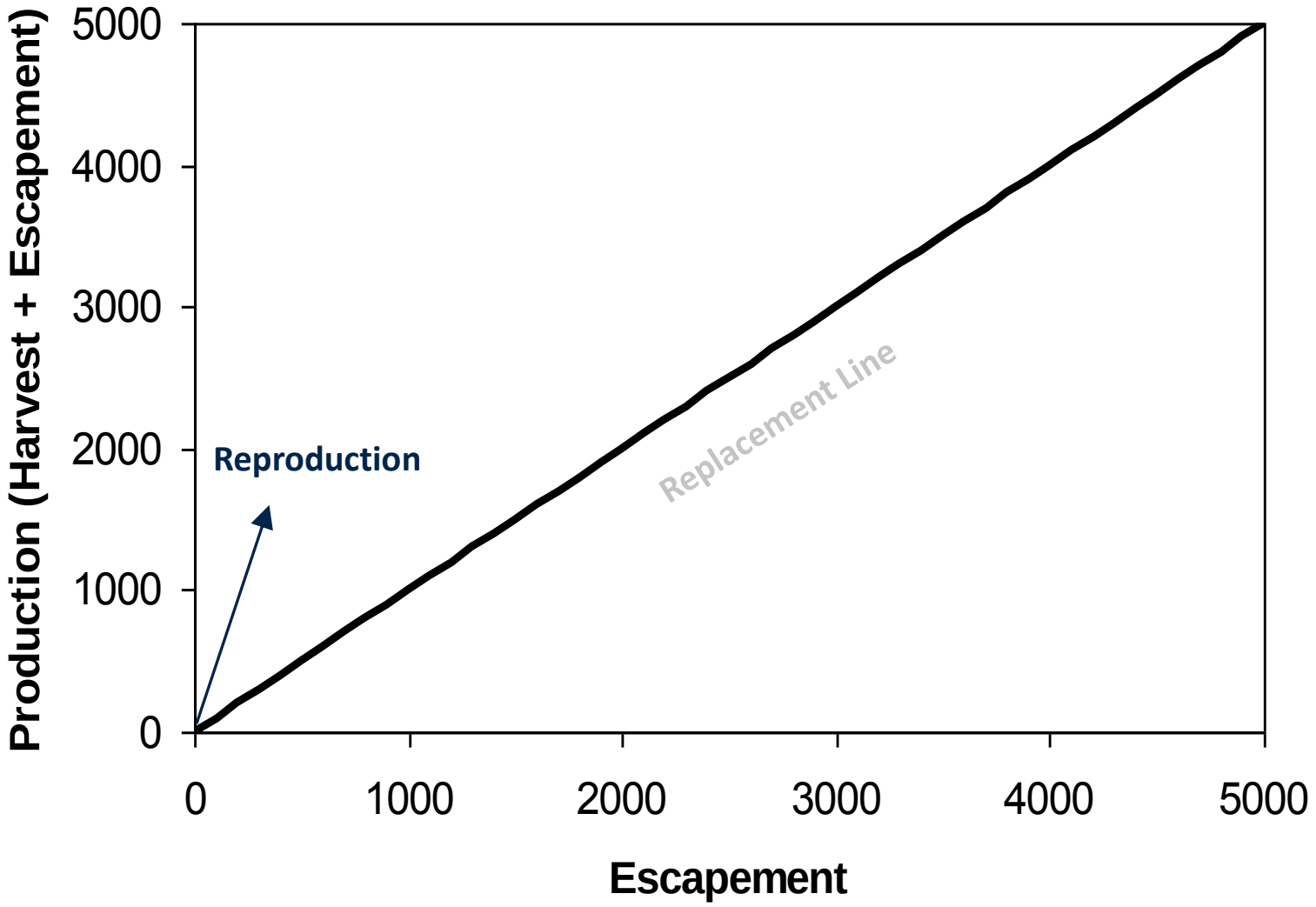
Theory of Salmon Production

There is a potential for yields only when production is greater than escapement



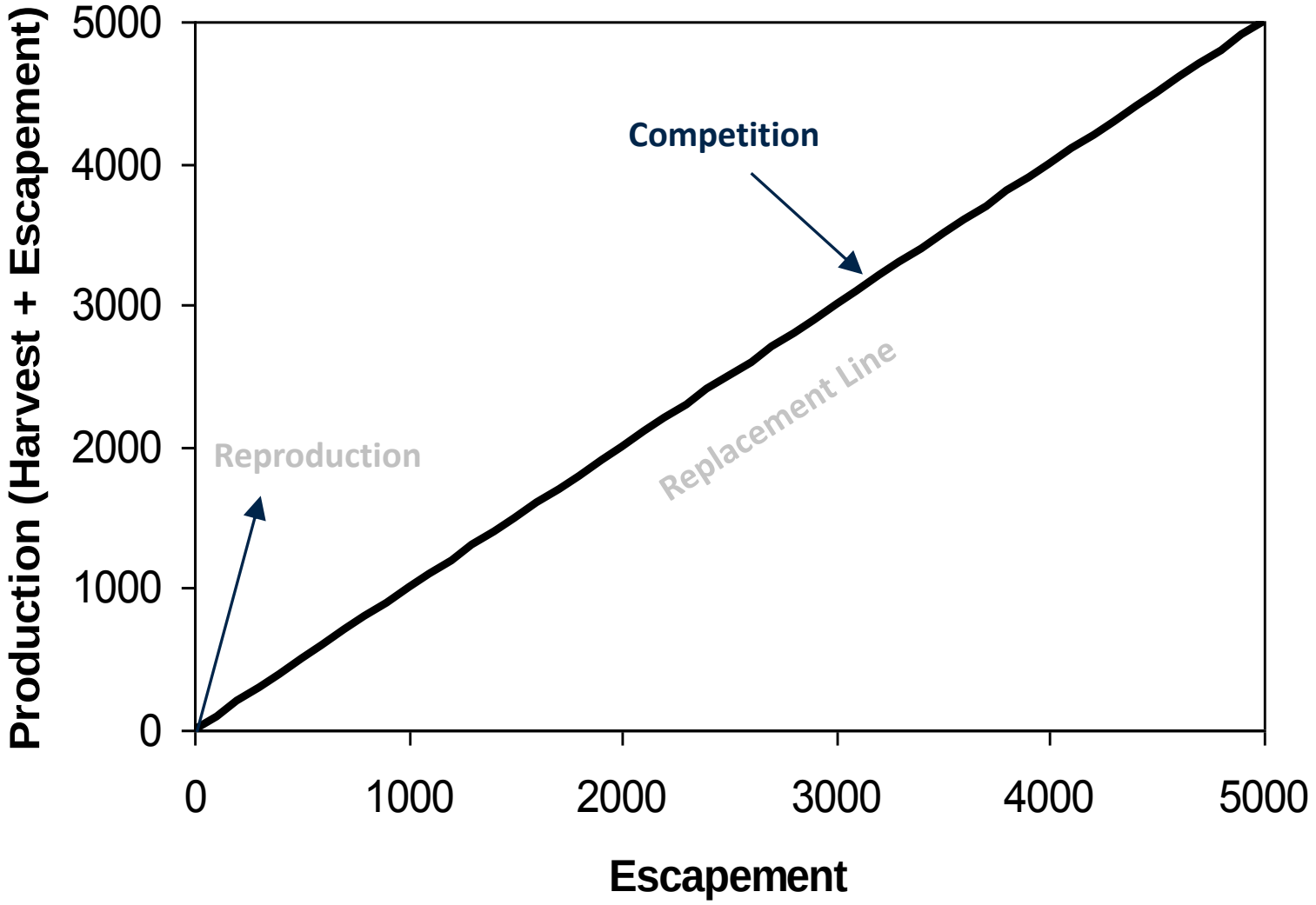
Theory of Salmon Production

Potential yields can be realized because of the reproductive capacity of salmon, but…



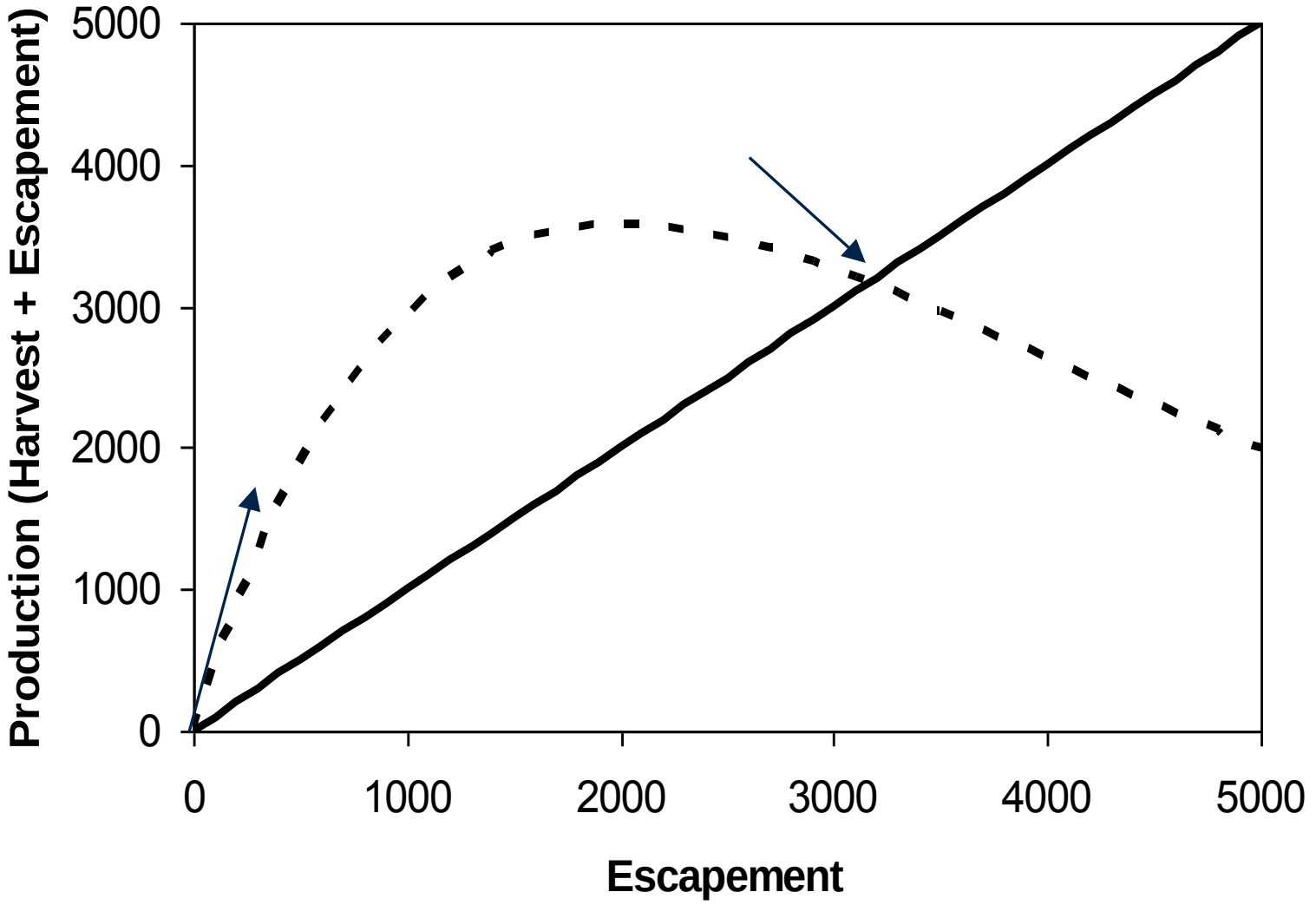
Theory of Salmon Production

…as escapements are increased, competition increases, which limits potential yields.



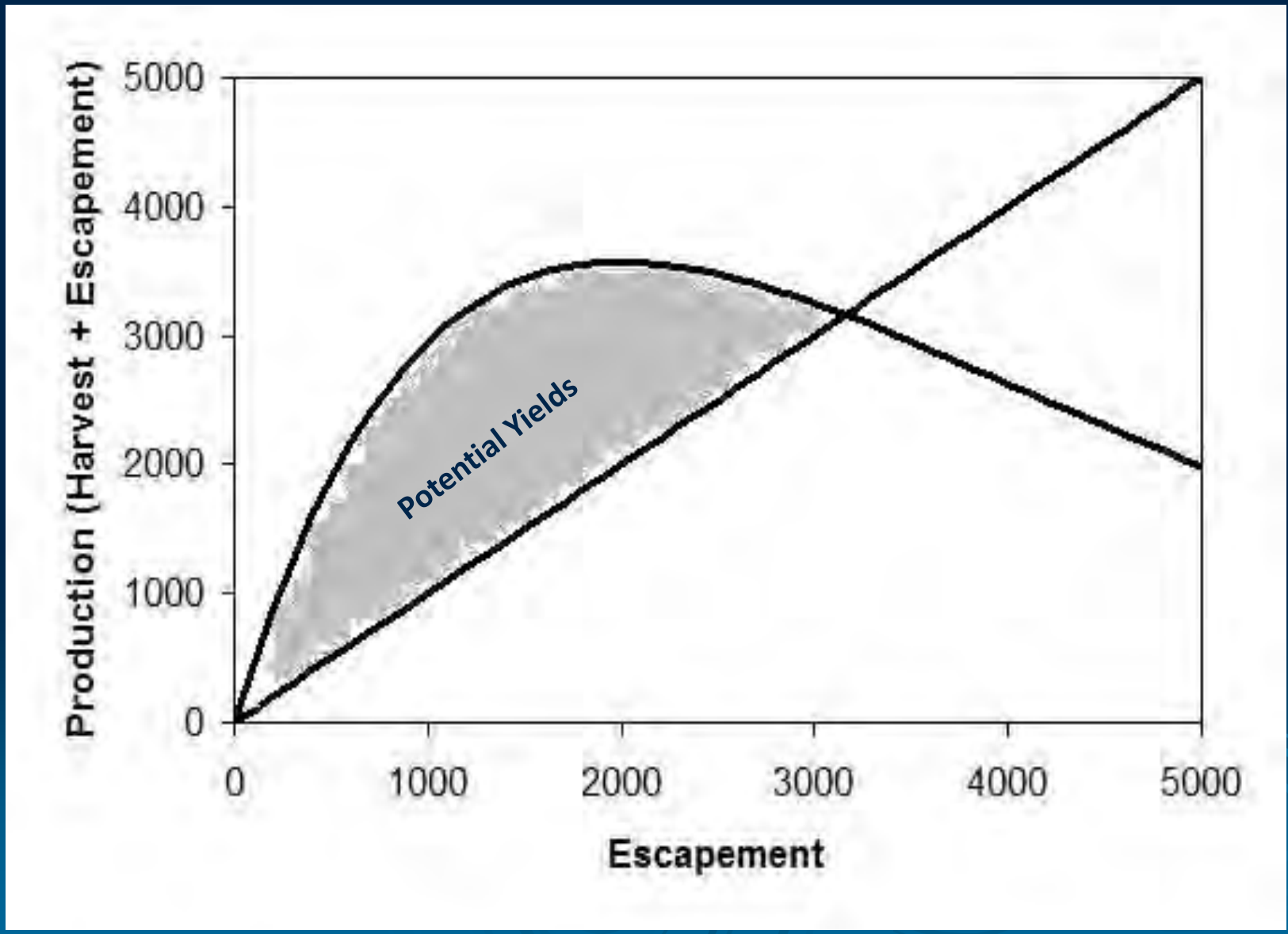
Theory of Salmon Production

We can model the interaction of reproductive potential and competition using our data.



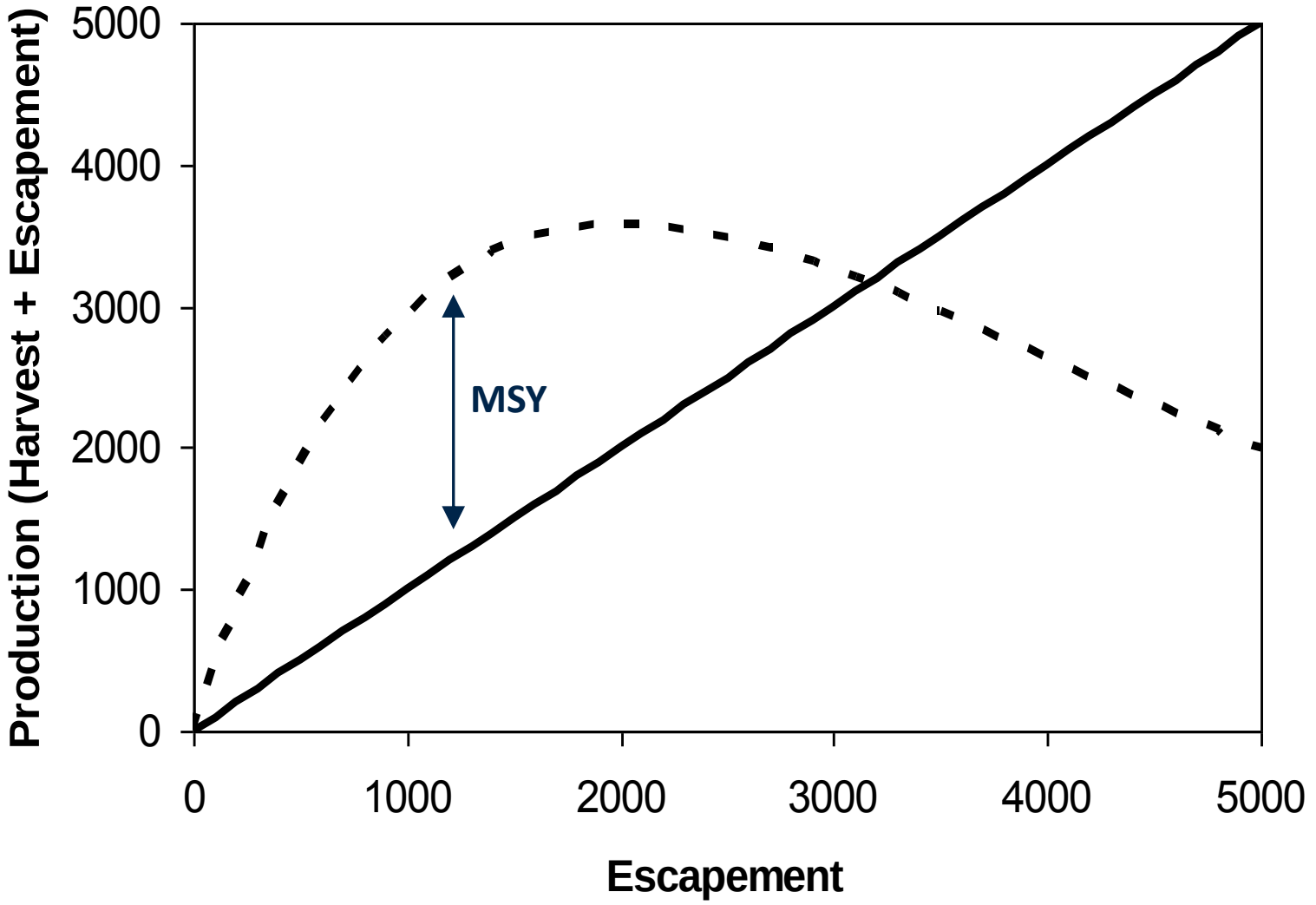
Theory of Salmon Production

The model helps to define potential yields relative to escapements.



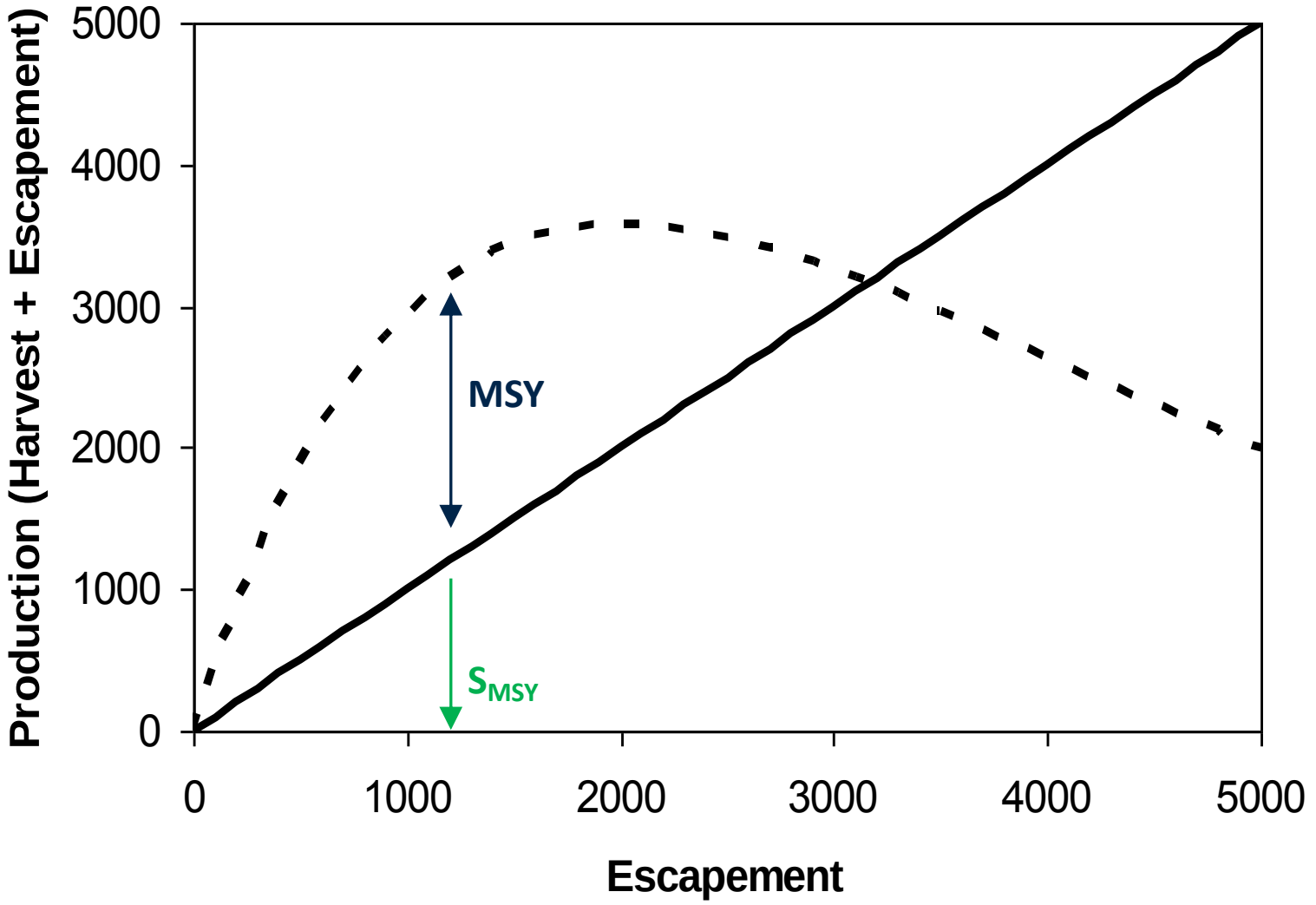
Theory of Salmon Production

MSY is the maximum sustained yield based on the model…



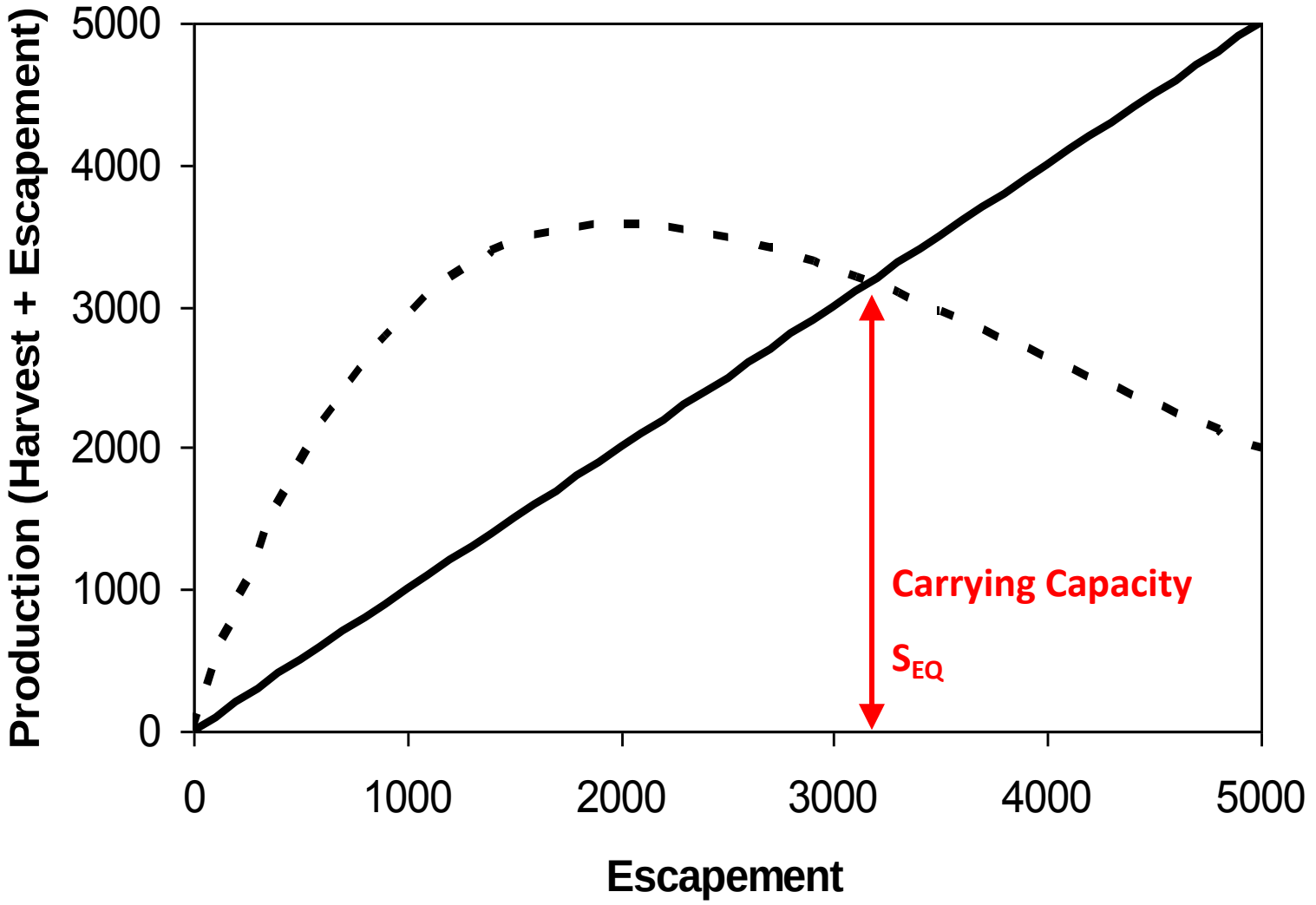
Theory of Salmon Production

…and is associated with a level of escapement that is expected to produce MSY.



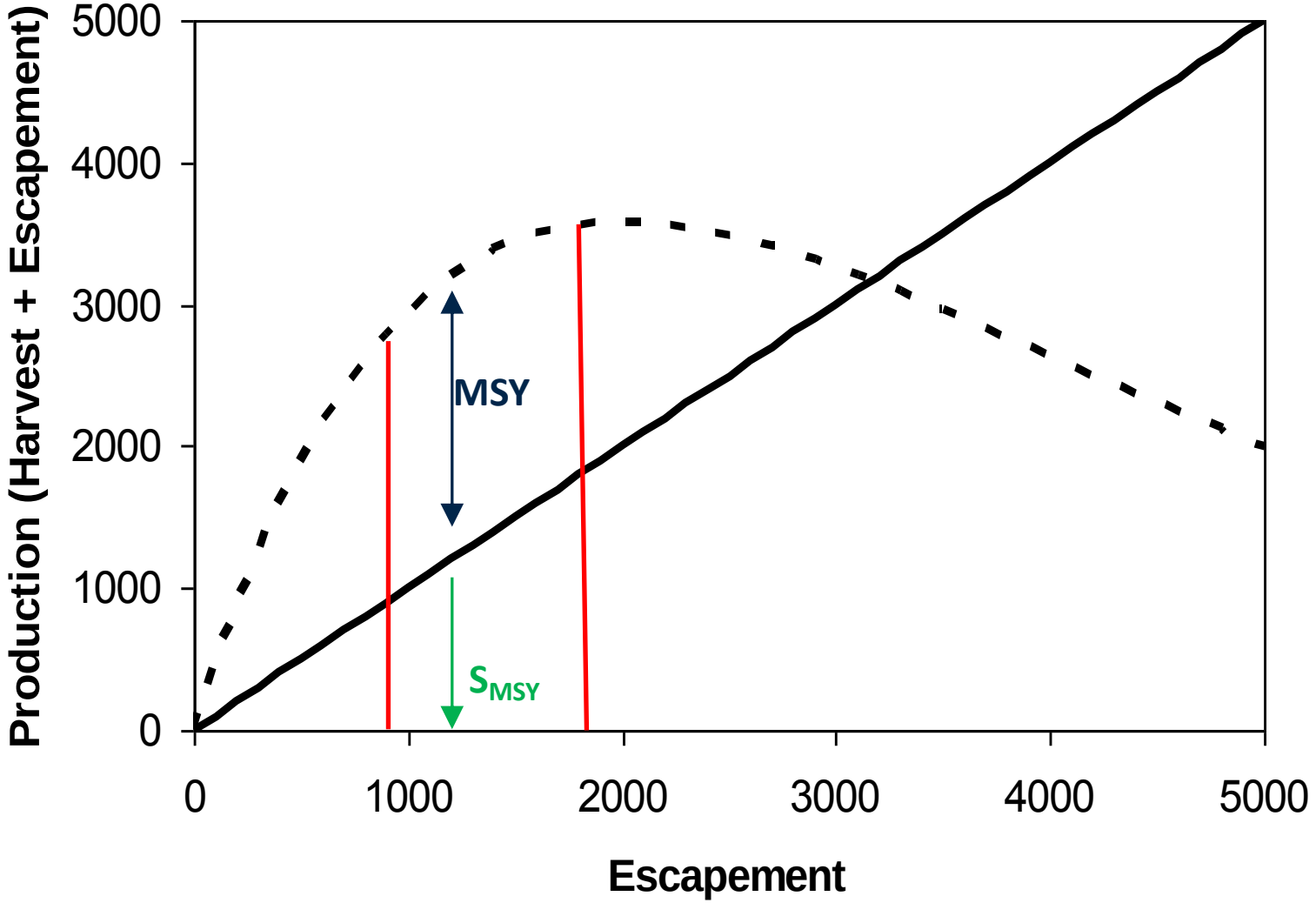
Theory of Salmon Production

Another quantity we can estimate from the model is the carrying capacity.



Theory of Salmon Production

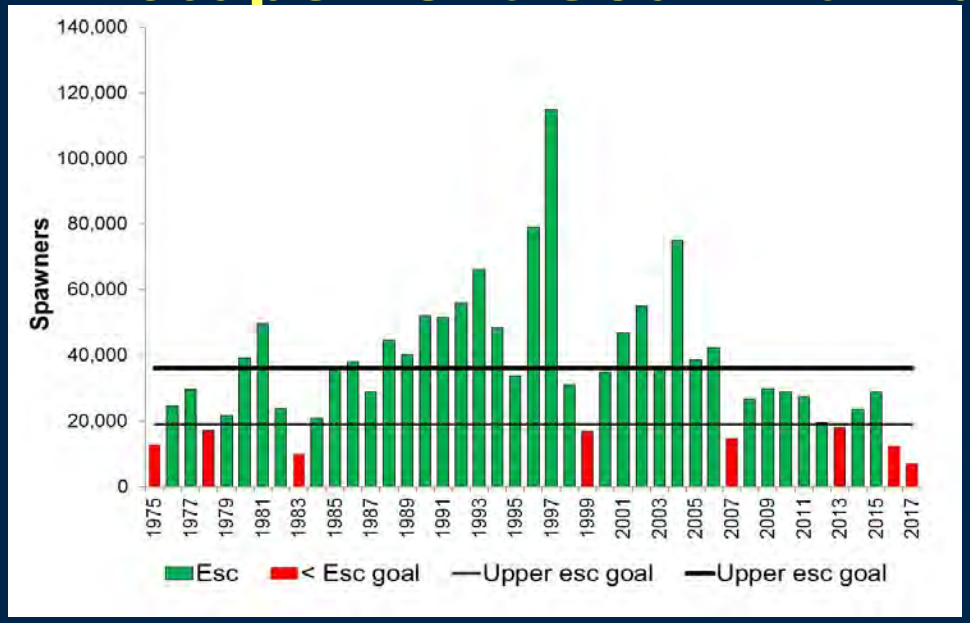
A range around the escapement that produces MSY is the theoretical basis of an escapement goal.

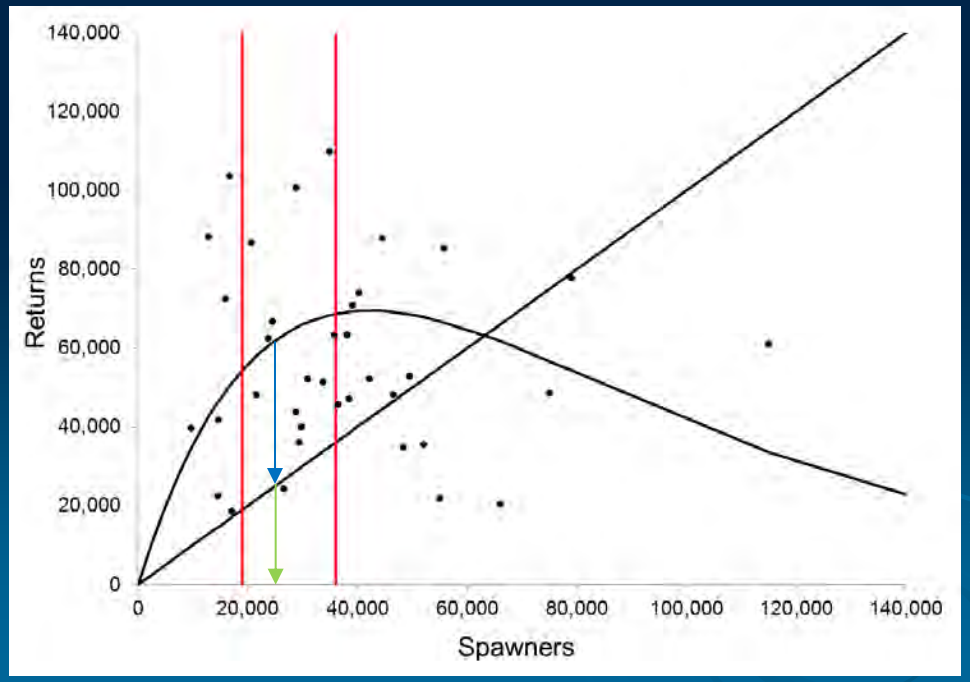


Escapement Goal with Full Harvest Information

Brood year	Spawners	Returns
1983	9,794	39,503
1973	14,565	22,399
1974	16,015	72,392
1975	12,920	88,043
1976	24,582	66,673
1977	29,497	36,010
1978	17,124	18,617
1979	21,617	48,174
1980	39,239	70,707
1981	49,559	52,717
1982	23,848	62,420
1984	20,778	86,734
1985	35,916	63,280
1986	38,111	63,230
1987	28,935	100,539
1988	44,524	87,819
1989	40,329	74,048
1990	52,142	35,529
1991	51,645	195,969
1992	55,889	85,234
1993	66,125	20,384
1994	48,368	34,701
1995	33,805	51,298
1996	79,019	77,749
1997	114,938	60,968
1998	31,039	52,005
1999	16,786	103,545
2000	34,997	109,715
2001	46,644	48,206
2002	55,044	21,779
2003	36,435	45,692
2004	75,032	48,452
2005	38,599	47,076
2006	42,296	51,986
2007	14,749	41,743
2008	26,645	24,314
2009	29,797	39,971
2010	28,769	43,679

Escapement Goal with Full Harvest Information





Brood year	Spawners	Returns	Average Spawners	Average Returns	Average R/S	Median Yield
1983	9,794	39,503				
1975	12,920	88,043				
1973	14,565	22,399				
2007	14,749	41,743	*15,000*	*55,000*	*3.7*	***30,000***
1974	16,015	72,392				
1999	16,786	103,545				
1978	17,124	18,617				
1984	20,778	86,734				
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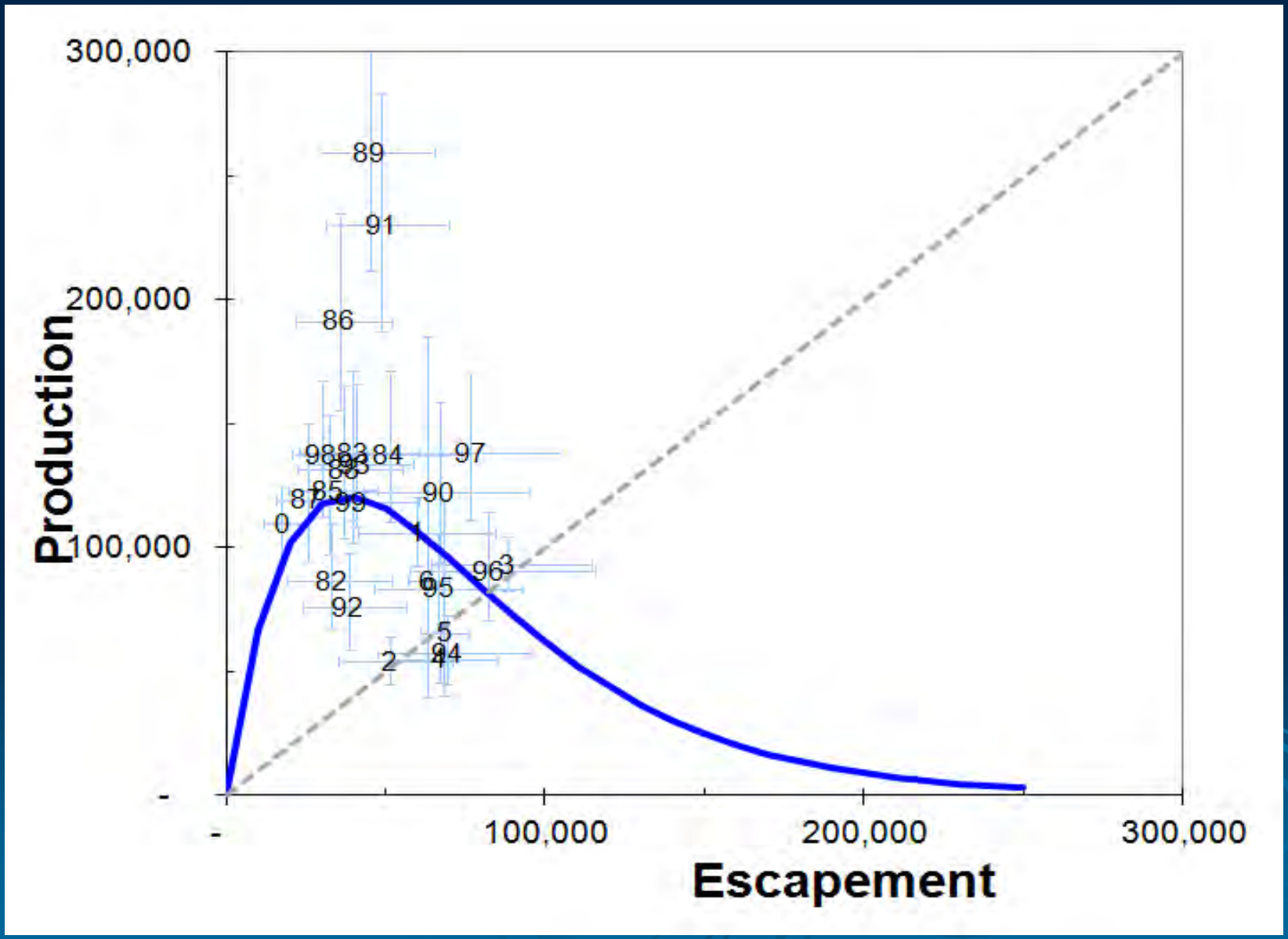
1976	24,582	66,673				
2008	26,645	24,314				
2010	28,769	43,679				
1987	28,935	100,539	*30,000*	*60,000*	*2.0*	***27,000***
1977	29,497	36,010				
2009	29,797	39,971				
1998	31,039	52,005				
1995	33,805	51,298				
2000	34,997	109,715				
1985	35,916	63,280				
2003	36,435	45,692				
1986	38,111	63,230				
2005	38,599	47,076				
1980	39,239	70,707				
1989	40,329	74,048				
2006	42,296	51,986				
1988	44,524	87,819				
2001	46,644	48,206				
1994	48,368	34,701	*50,000*	*60,000*	*1.2*	***5,800***
1981	49,559	52,717				
1991	51,645	195,969				
1990	52,142	35,529				
2002	55,044	21,779				
1992	55,889	85,234				
1993	66,125	20,384				
2004	75,032	48,452				
1996	79,019	77,749				
1997	114,938	60,968				

Uncertainty and Escapement Goals

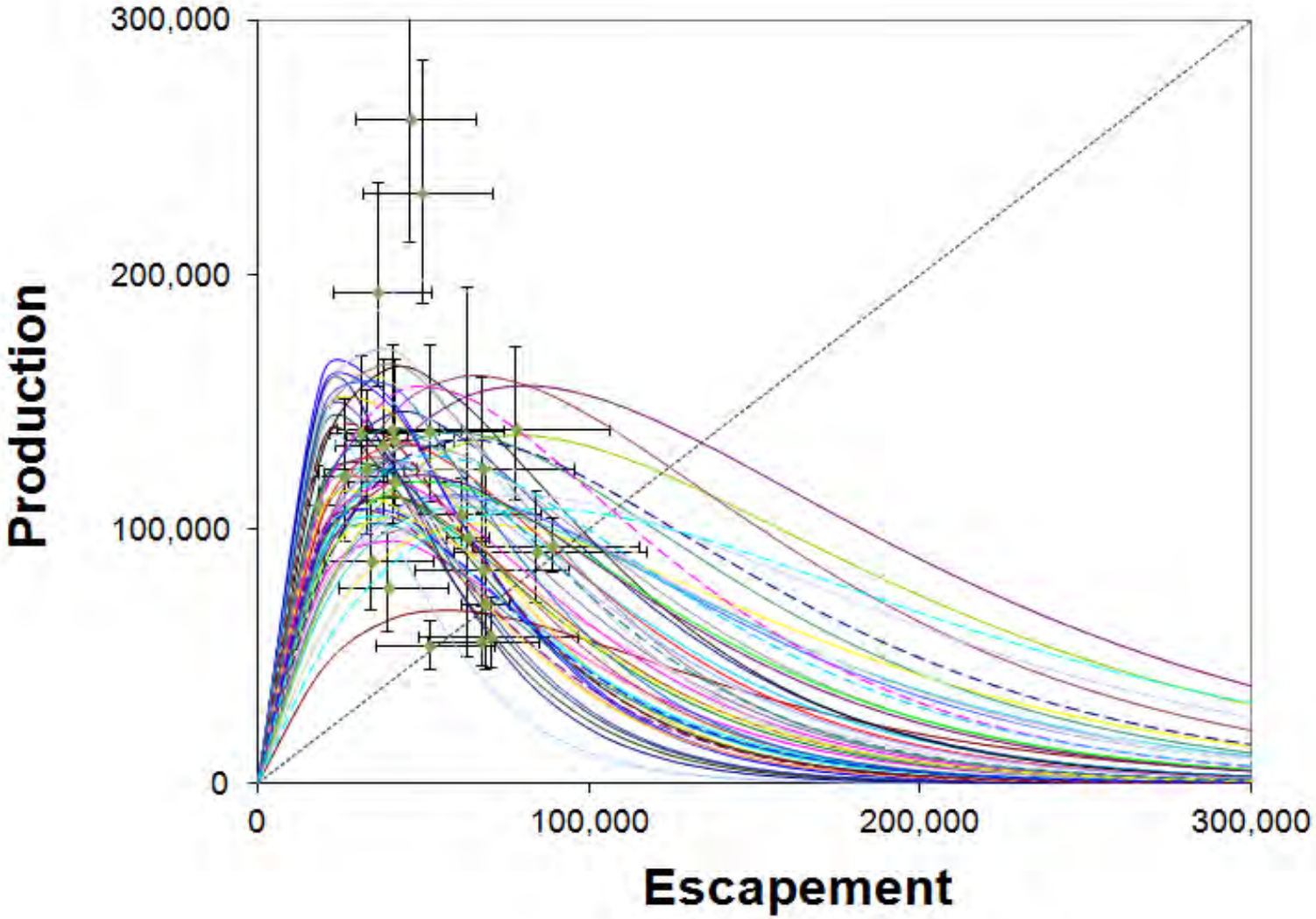
Uncertainty and Escapement Goals

Actual production data will look very different from our simple production model …



Uncertainty and Escapement Goals

…and this uncertainty is factored into the choice of escapement goal range.



Why and How Do Escapement Goals Change Over Time?

Why Do Escapement Goals Change?

- Changes in One or More Factors
  - Assessment
  - Biological
  - Fishery-Related

How Do Escapement Goals Change?

- Evolution of a goal is usually driven by improvement in information content and model development
- Some Simple Scenarios
  - Low Harvest Rate Scenario
  - High Harvest Rate Scenario

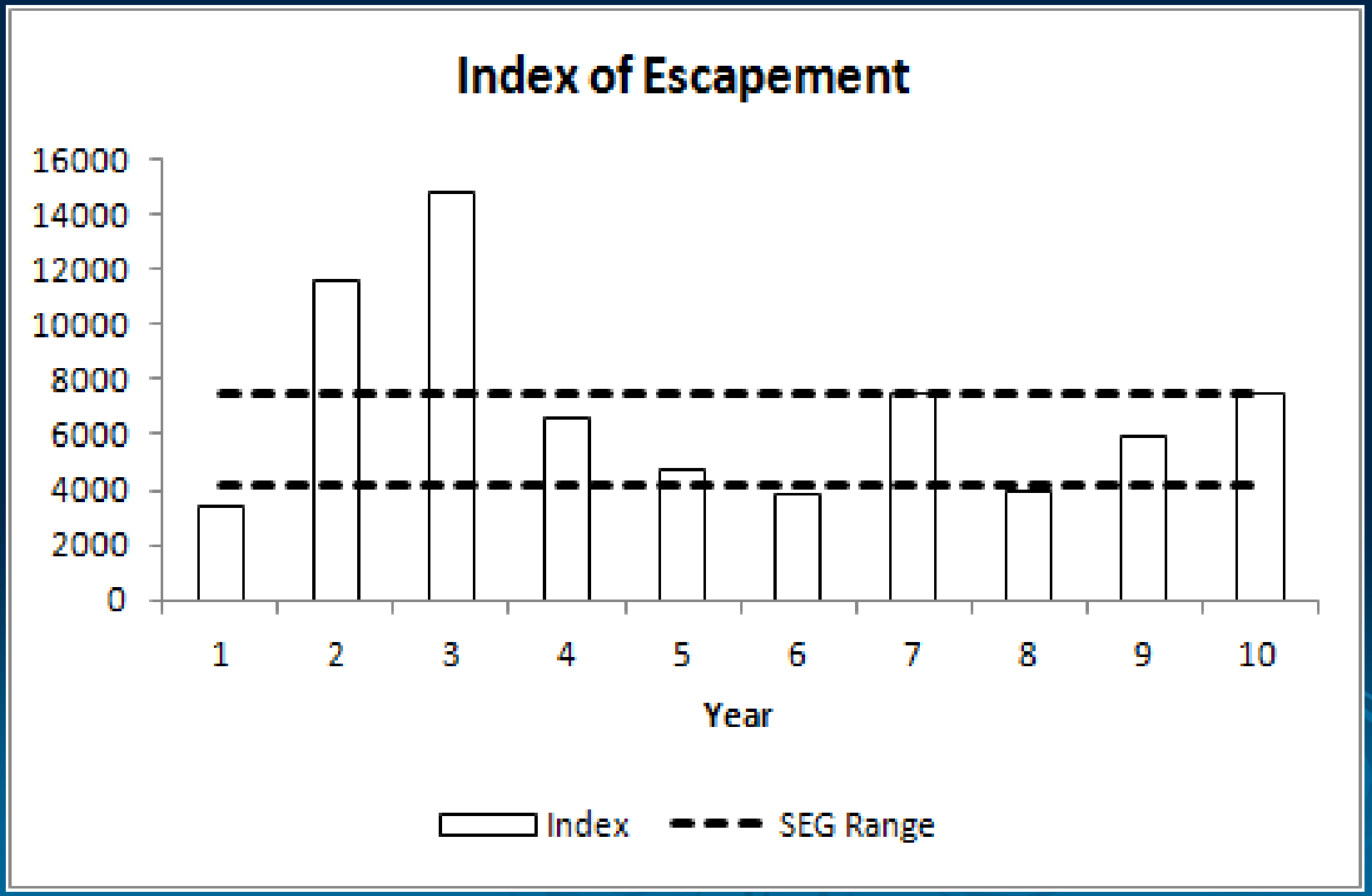
How Do Escapement Goals Change?
Low Harvest Rate Scenario

- Assessment begins with indexing of escapement only
- Stock-specific harvests are unknown
- Initial escapement goal based on history of escapement only
- Improvement of assessment drives refinement of goal

How Do Escapement Goals Change?

Low Harvest Rate Scenario

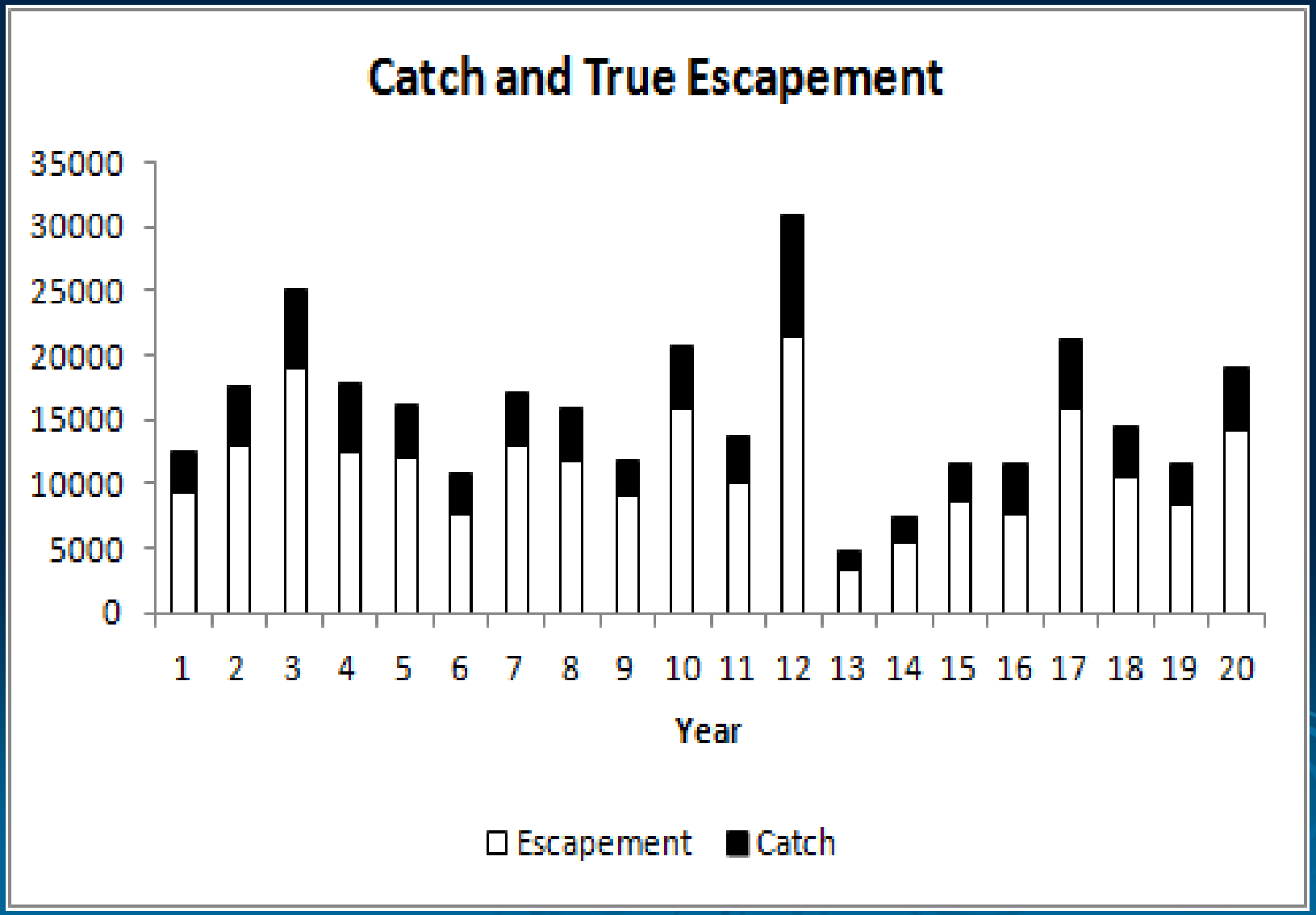
Assessment is by a simple aerial survey, with a goal based on keeping indexed escapements within the observed range.



How Do Escapement Goals Change?

Low Harvest Rate Scenario

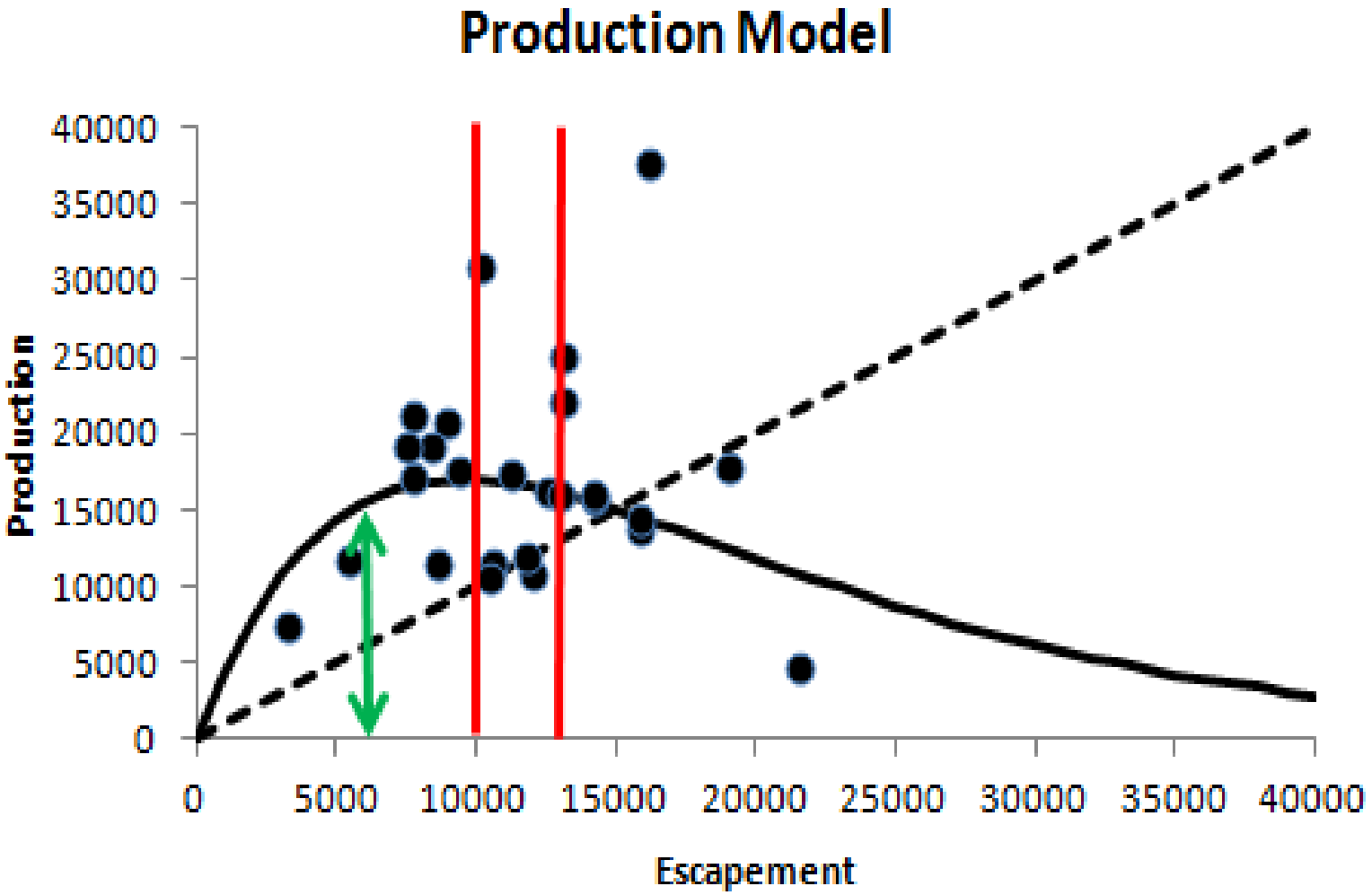
Once assessment improves, our understanding of harvest rate and production improves.



How Do Escapement Goals Change?

Low Harvest Rate Scenario

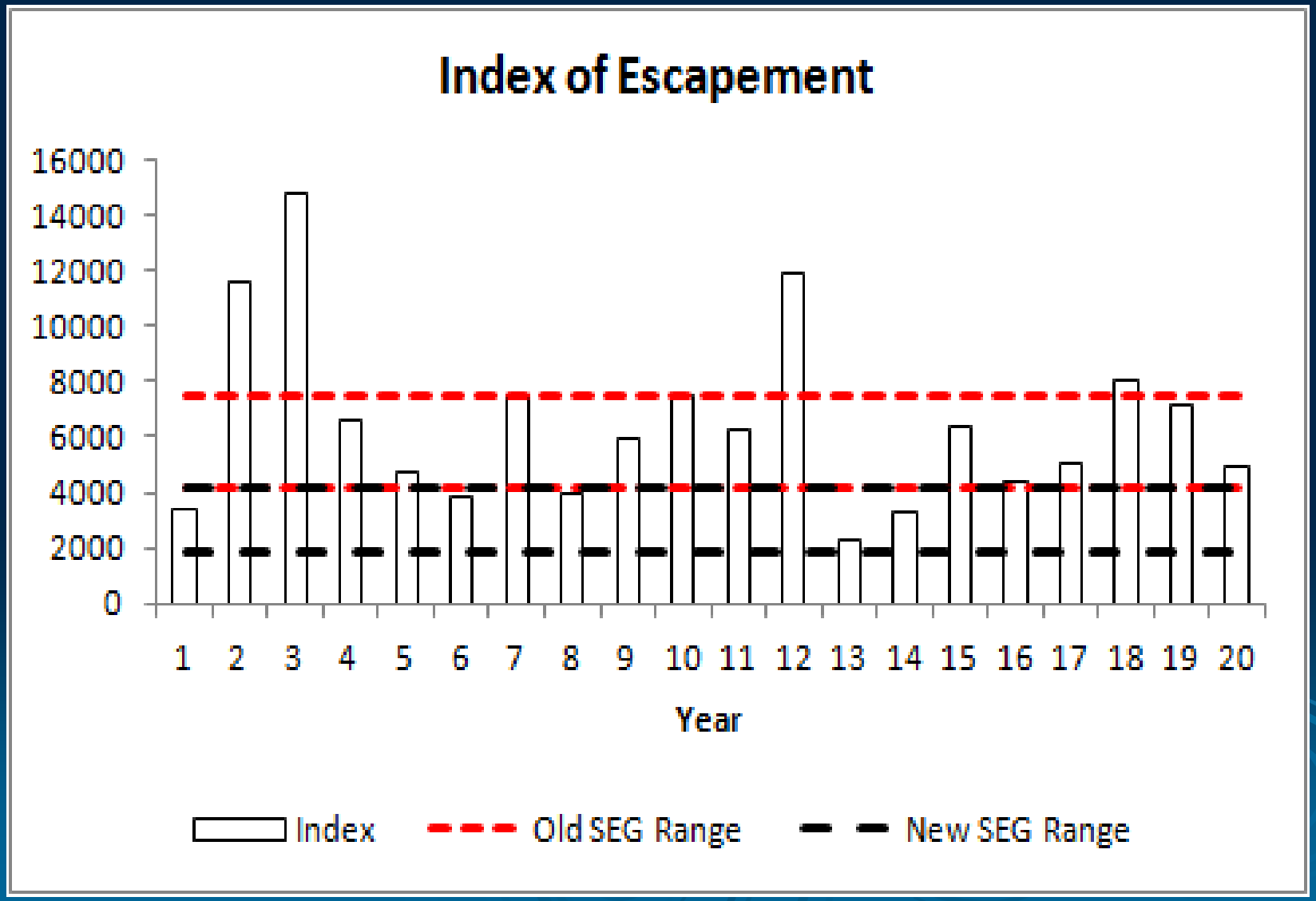
Production model shows that escapement goal should be lowered to increase yields.



How Do Escapement Goals Change?

Low Harvest Rate Scenario

New escapement goal can be recast back to original aerial survey index units if needed.



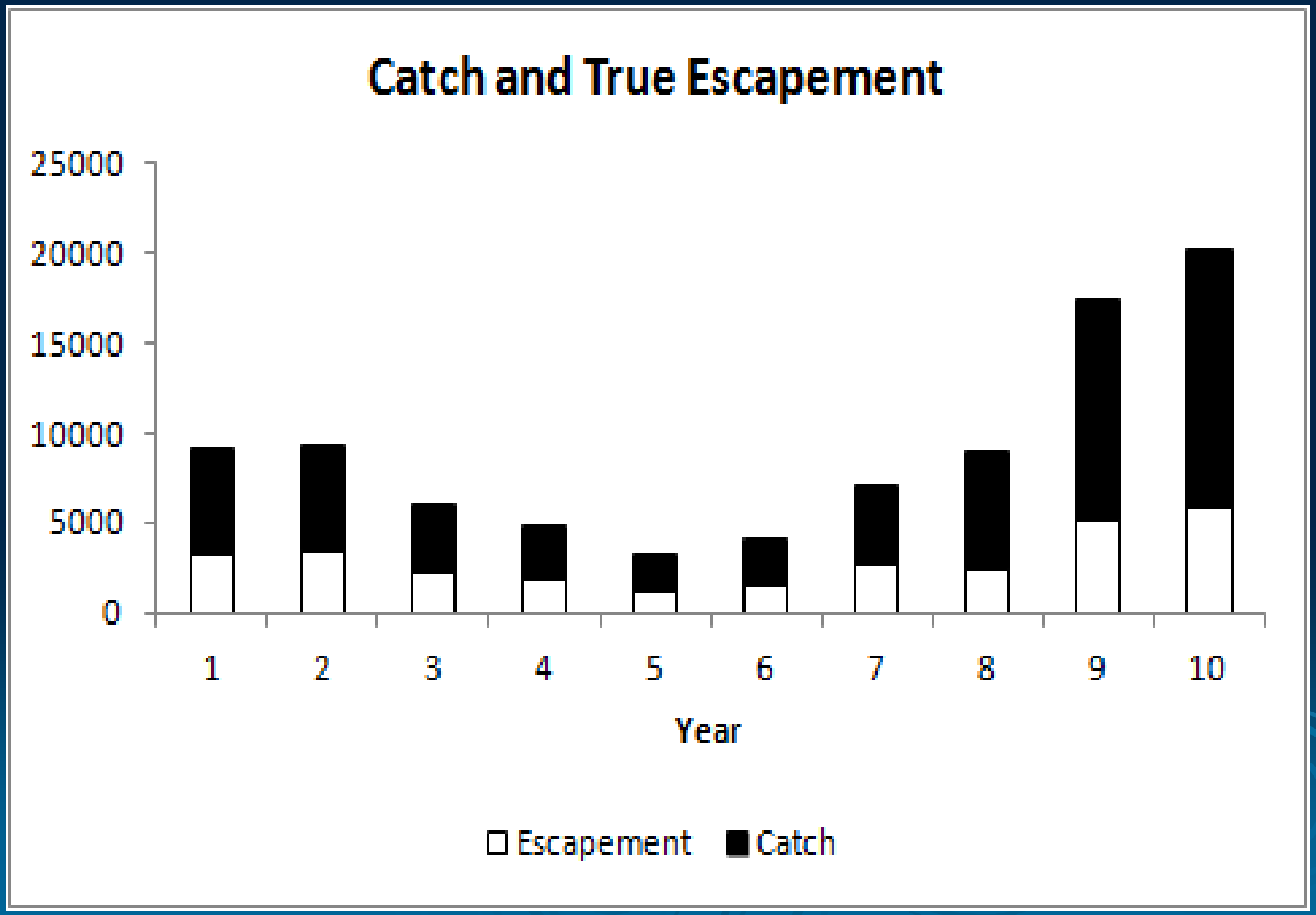
How Do Escapement Goals Change?
High Harvest Rate Scenario

- Full assessments are available early on
- Initial goal analyses are inconclusive
- Initial escapement goal based on history of escapement only
- Inclusion of more information drives refinement of goal

How Do Escapement Goals Change?

High Harvest Rate Scenario

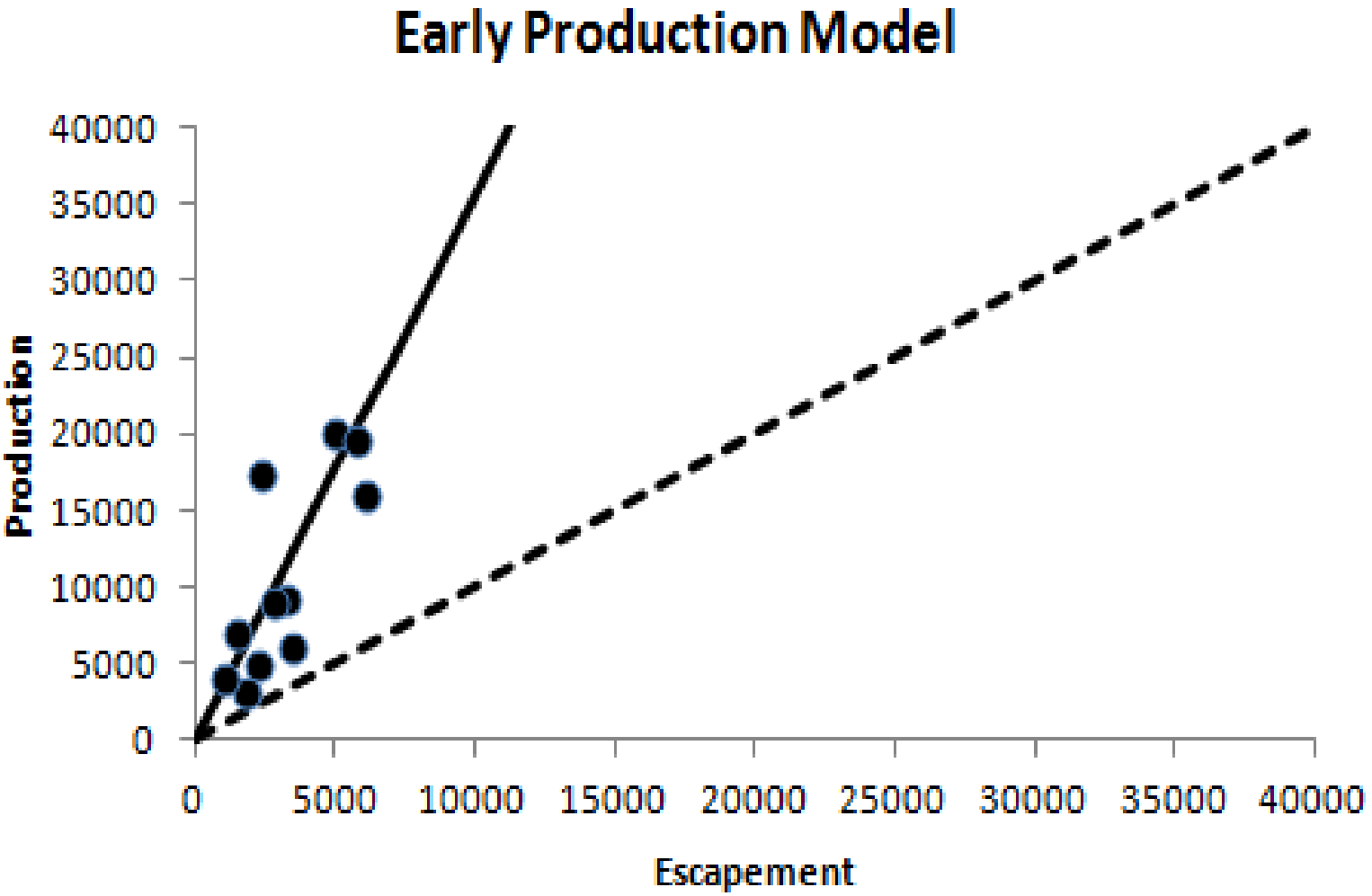
Assessment begins with complete estimates of catch and escapement…



How Do Escapement Goals Change?

High Harvest Rate Scenario

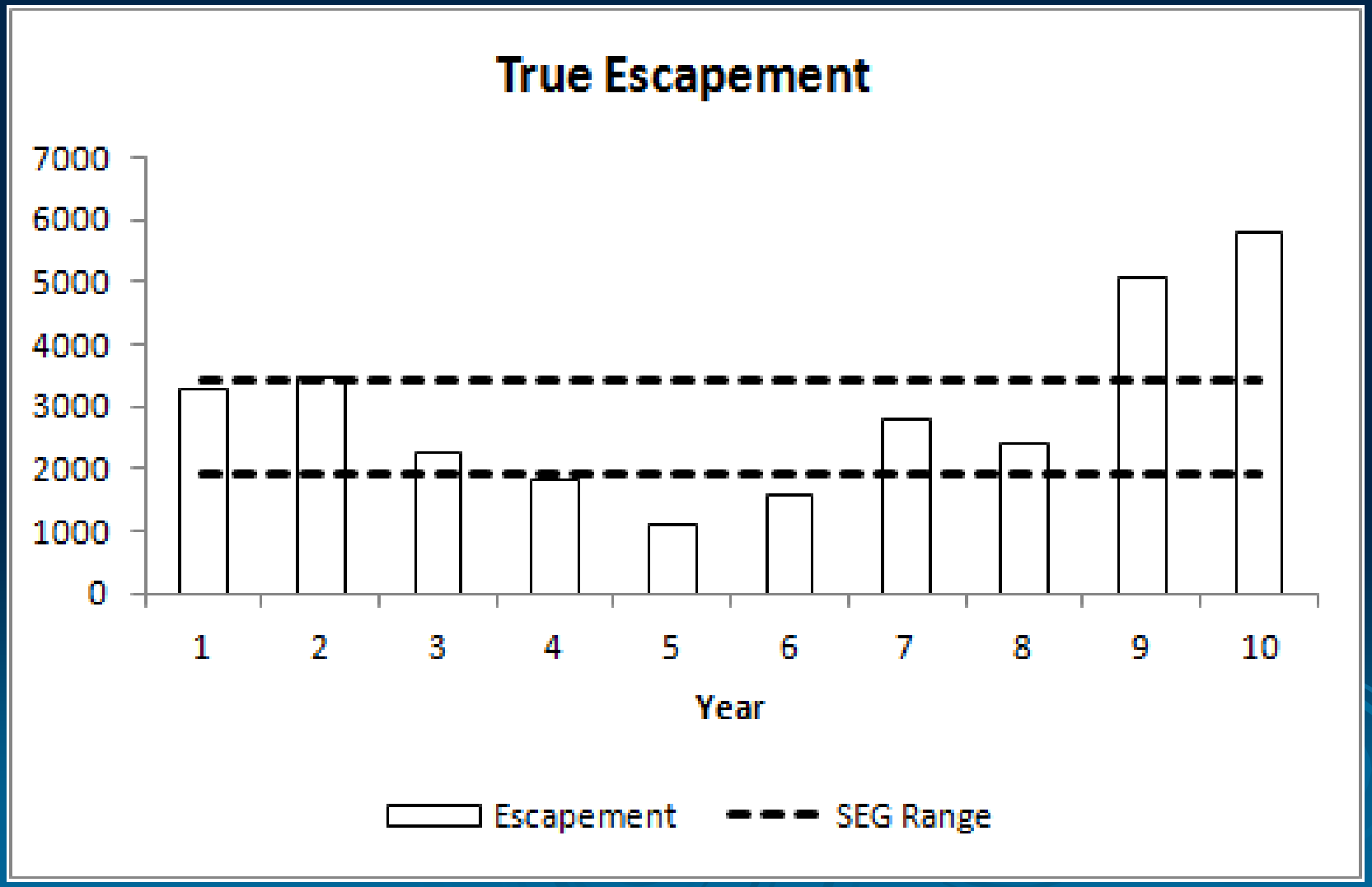
…but our production model is not informative about what the escapement goal should be.



How Do Escapement Goals Change?

High Harvest Rate Scenario

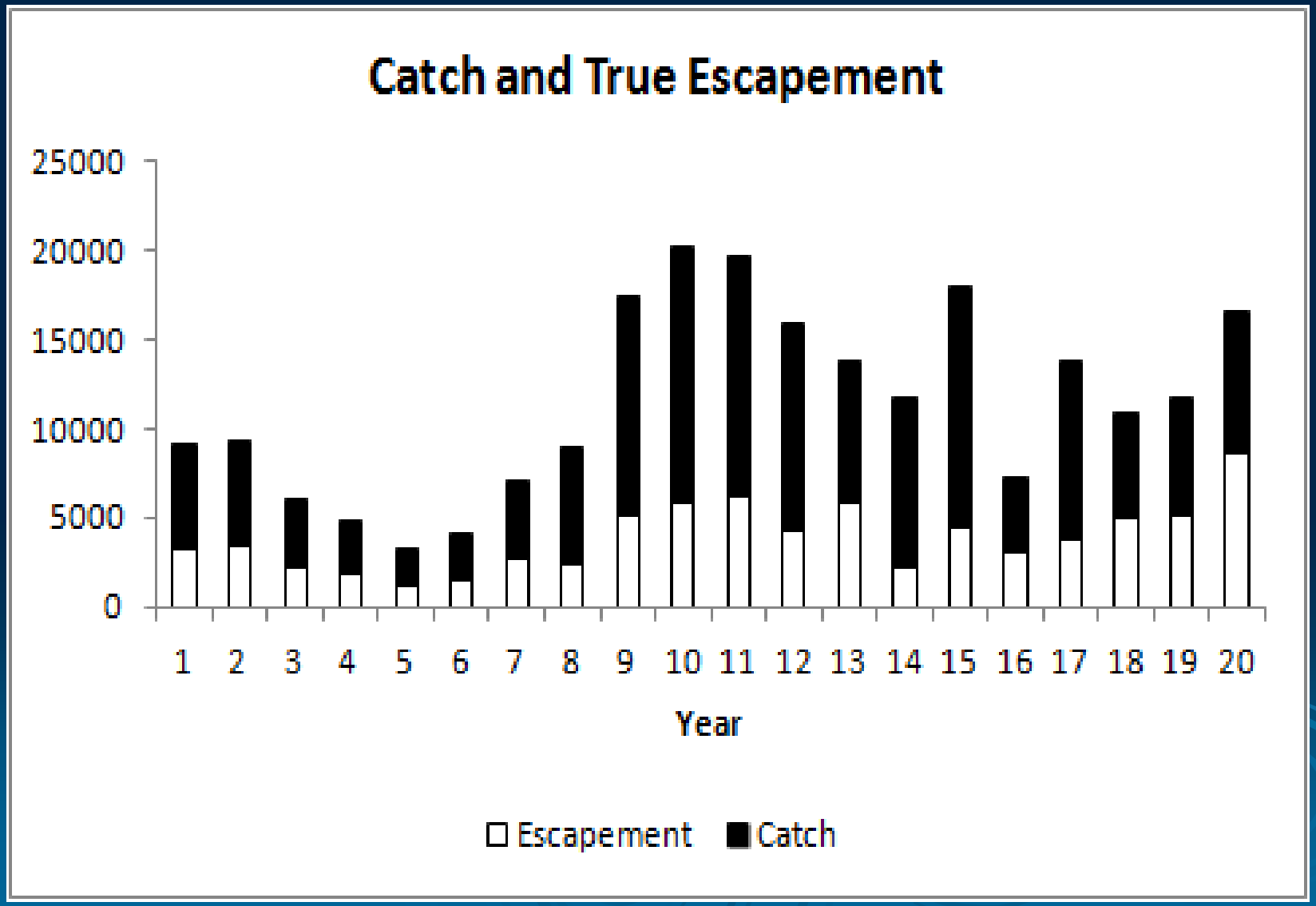
The initial escapement goal is based on the history of escapements, not the production model.



How Do Escapement Goals Change?

High Harvest Rate Scenario

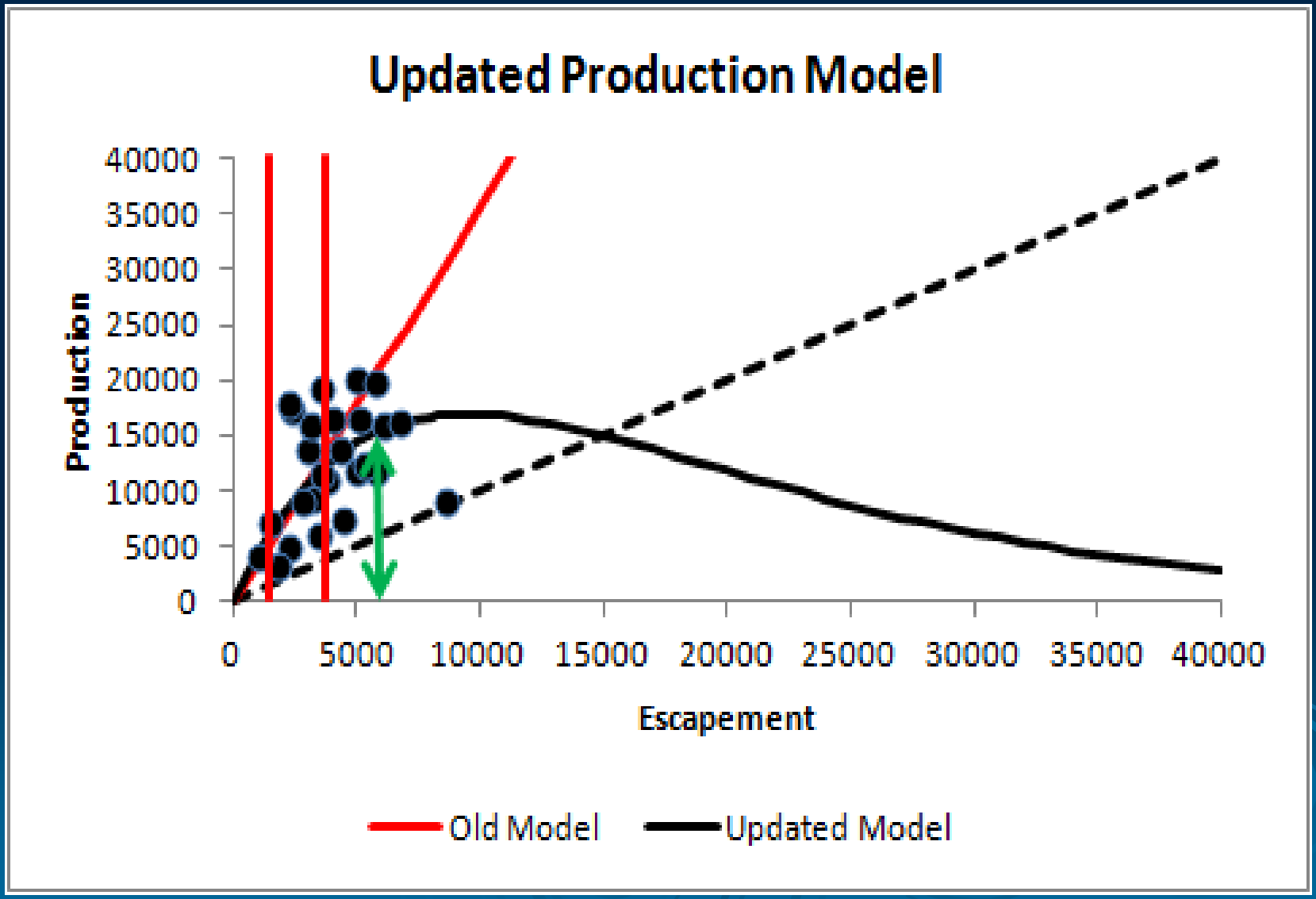
As we collect more production data, the range of escapements increases…



How Do Escapement Goals Change?

High Harvest Rate Scenario

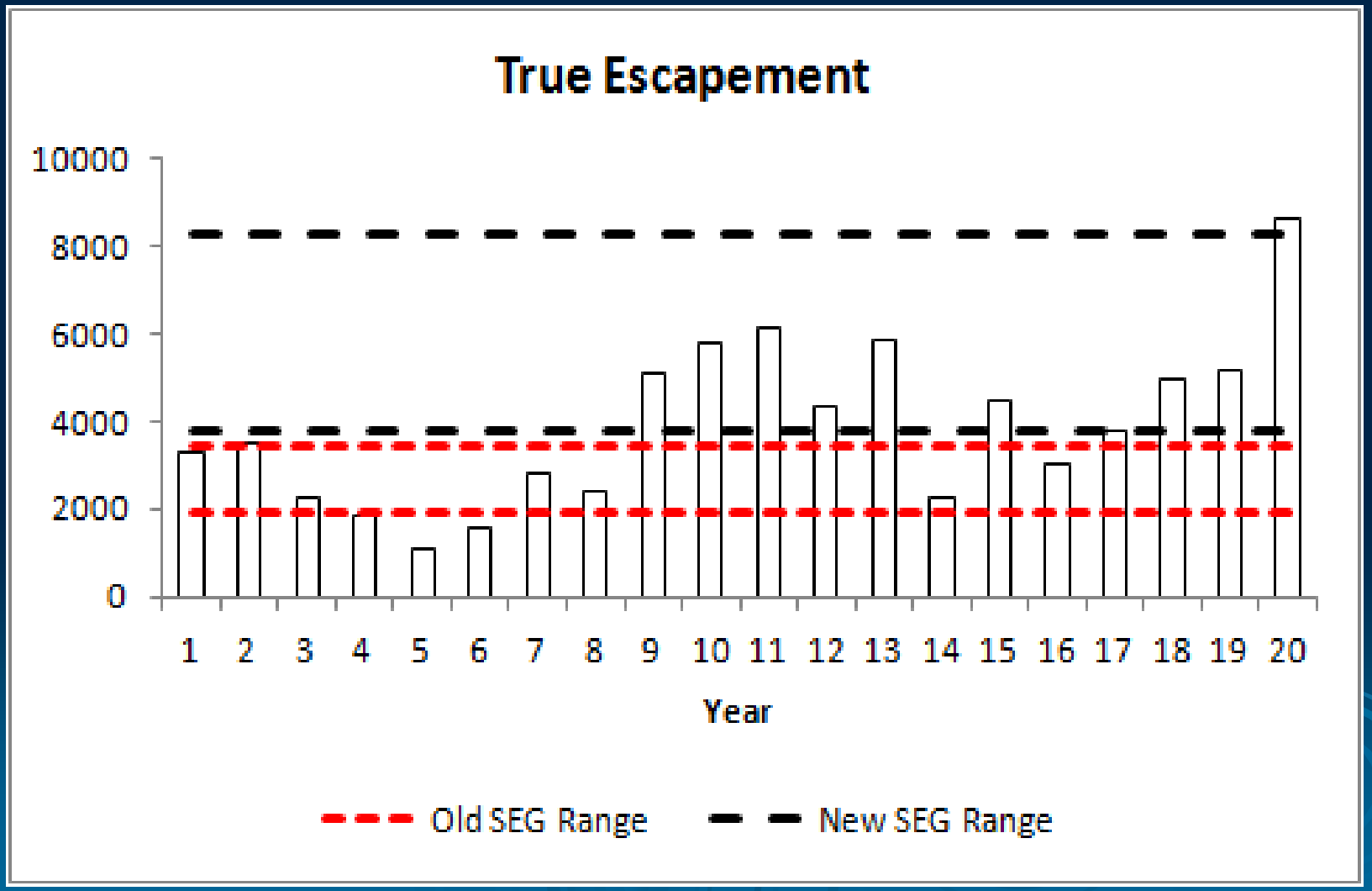
…and we are able to build a defensible production model.



How Do Escapement Goals Change?

High Harvest Rate Scenario

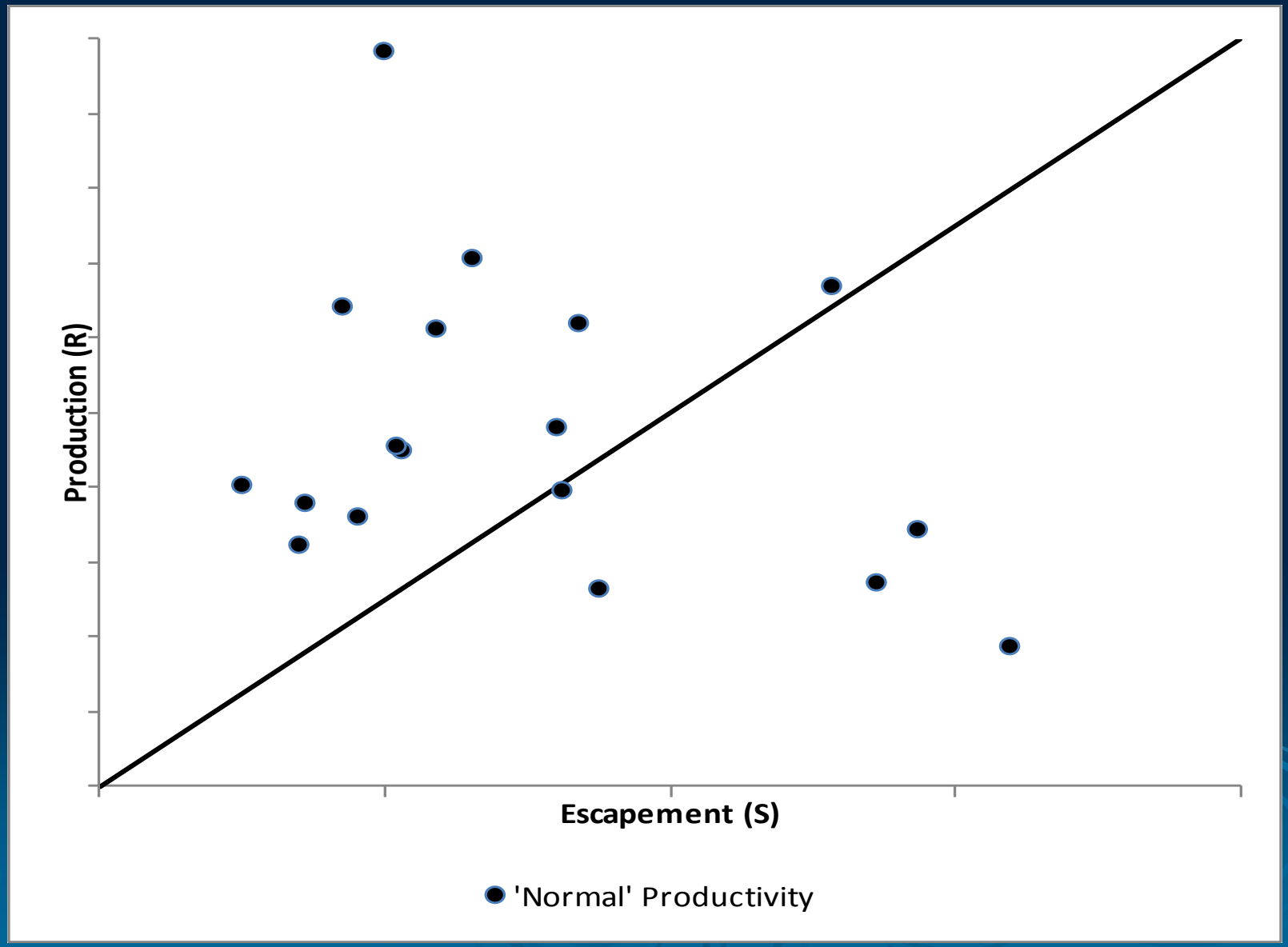
Results of the production model show that yields could be increased by increasing the escapement goal.



Effect of Productivity Declines on Escapement Goals

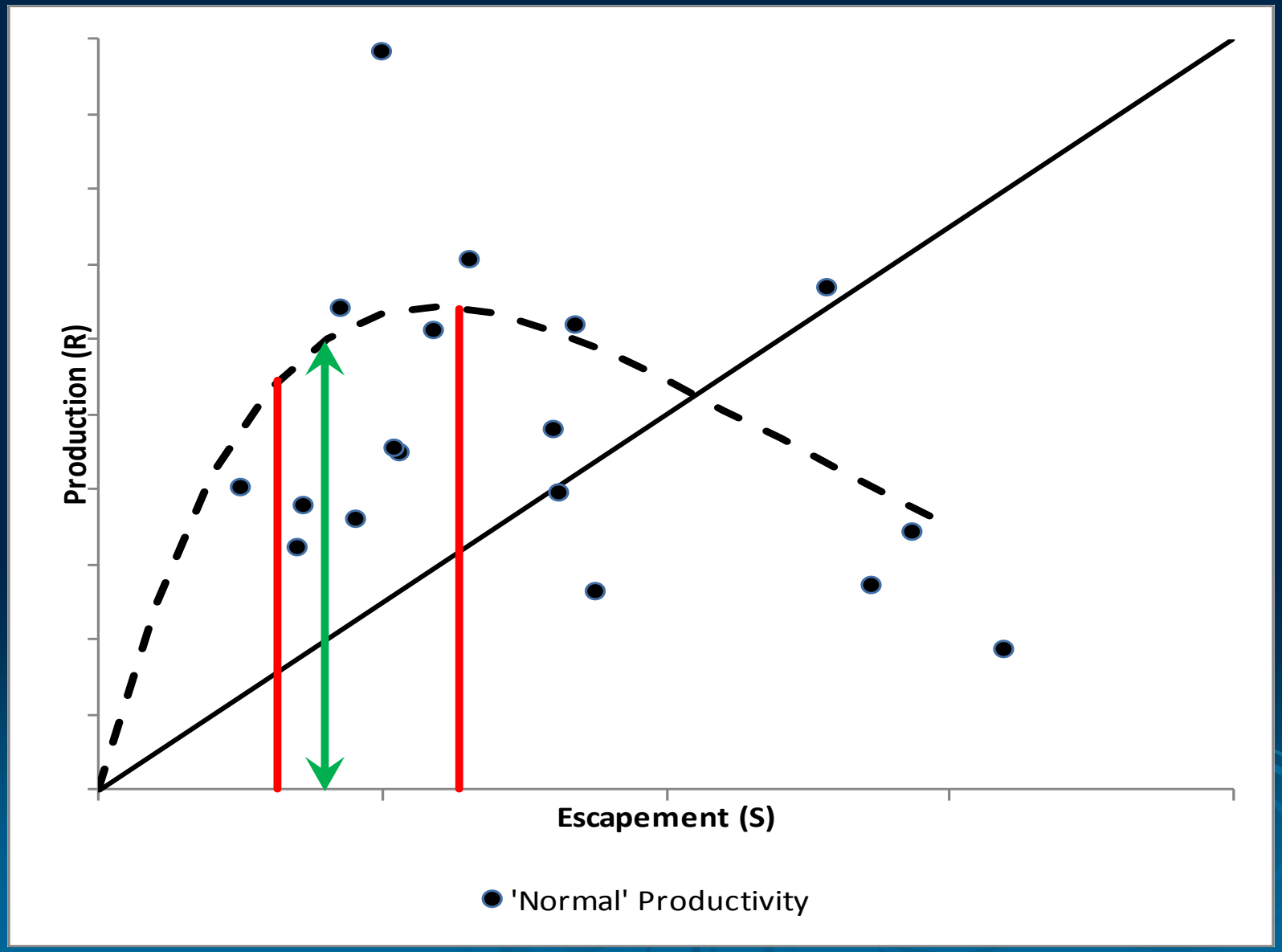
Escapement Goals as Productivity Declines

During a period of ‘normal’ productivity…



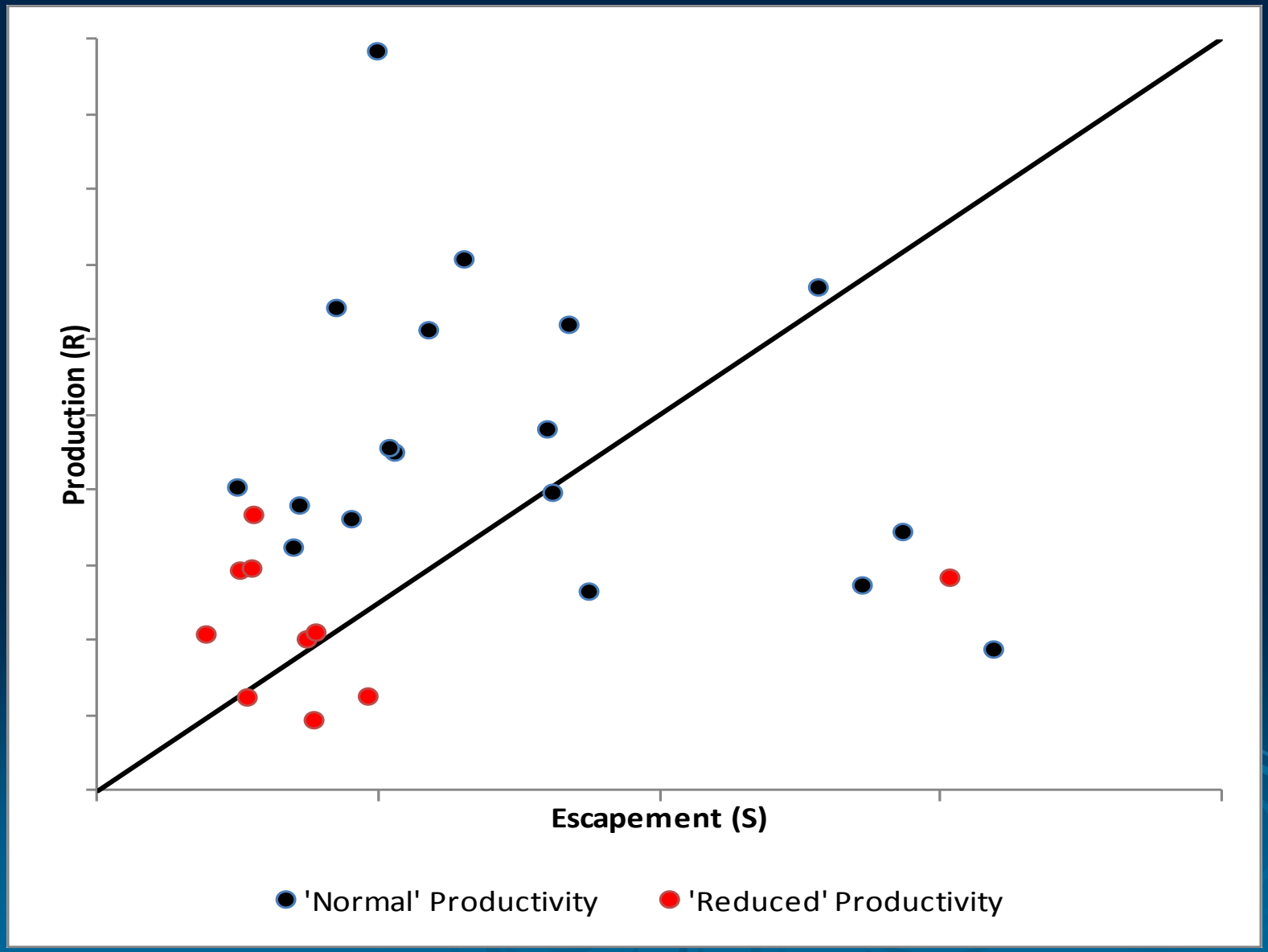
Escapement Goals as Productivity Declines

…we can fit the production model and develop an escapement goal range.



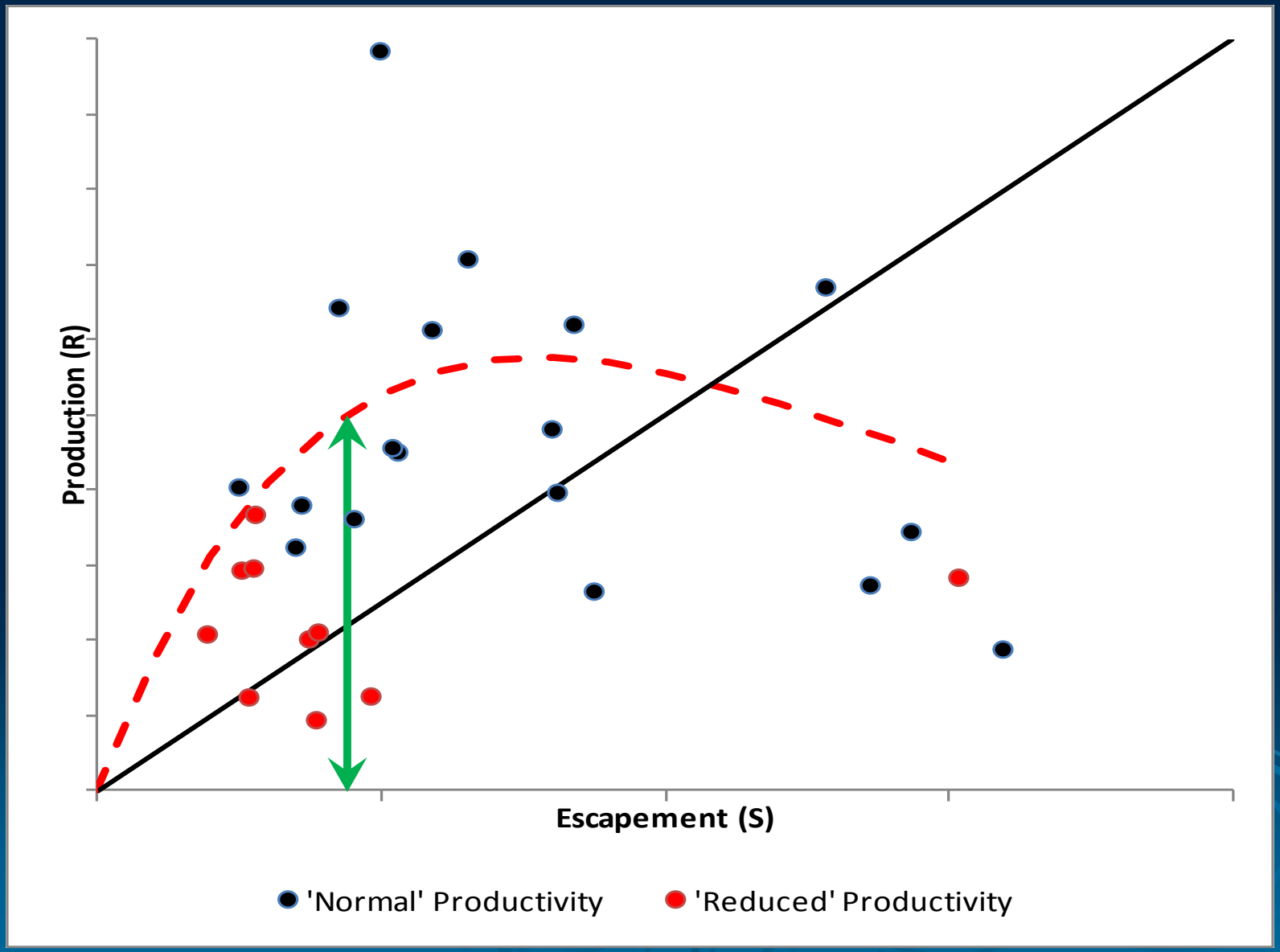
Escapement Goals as Productivity Declines

As productivity declines we will see reductions in **production and escapement**…



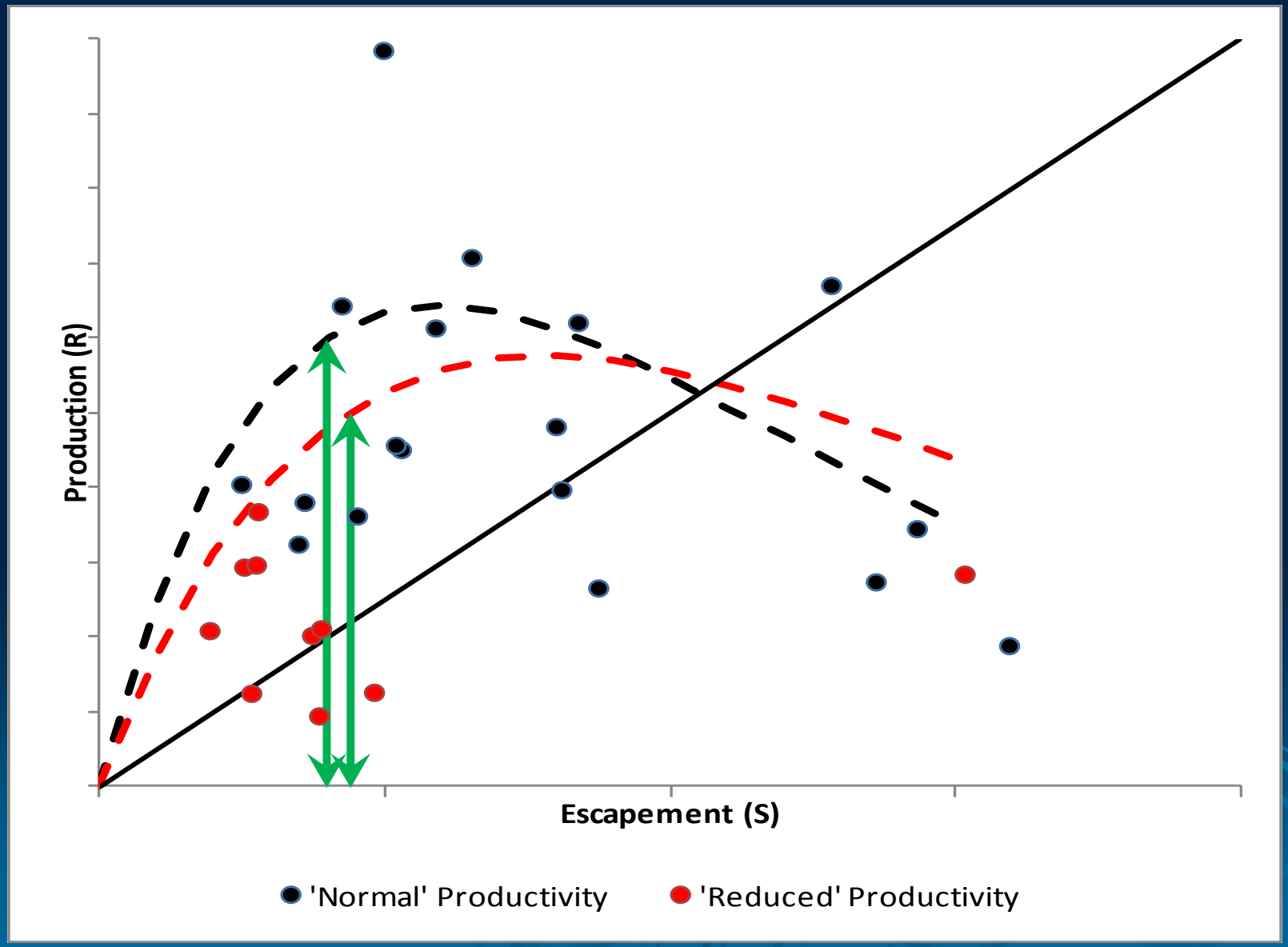
Escapement Goals as Productivity Declines

…and can fit a new production model to all of the data…



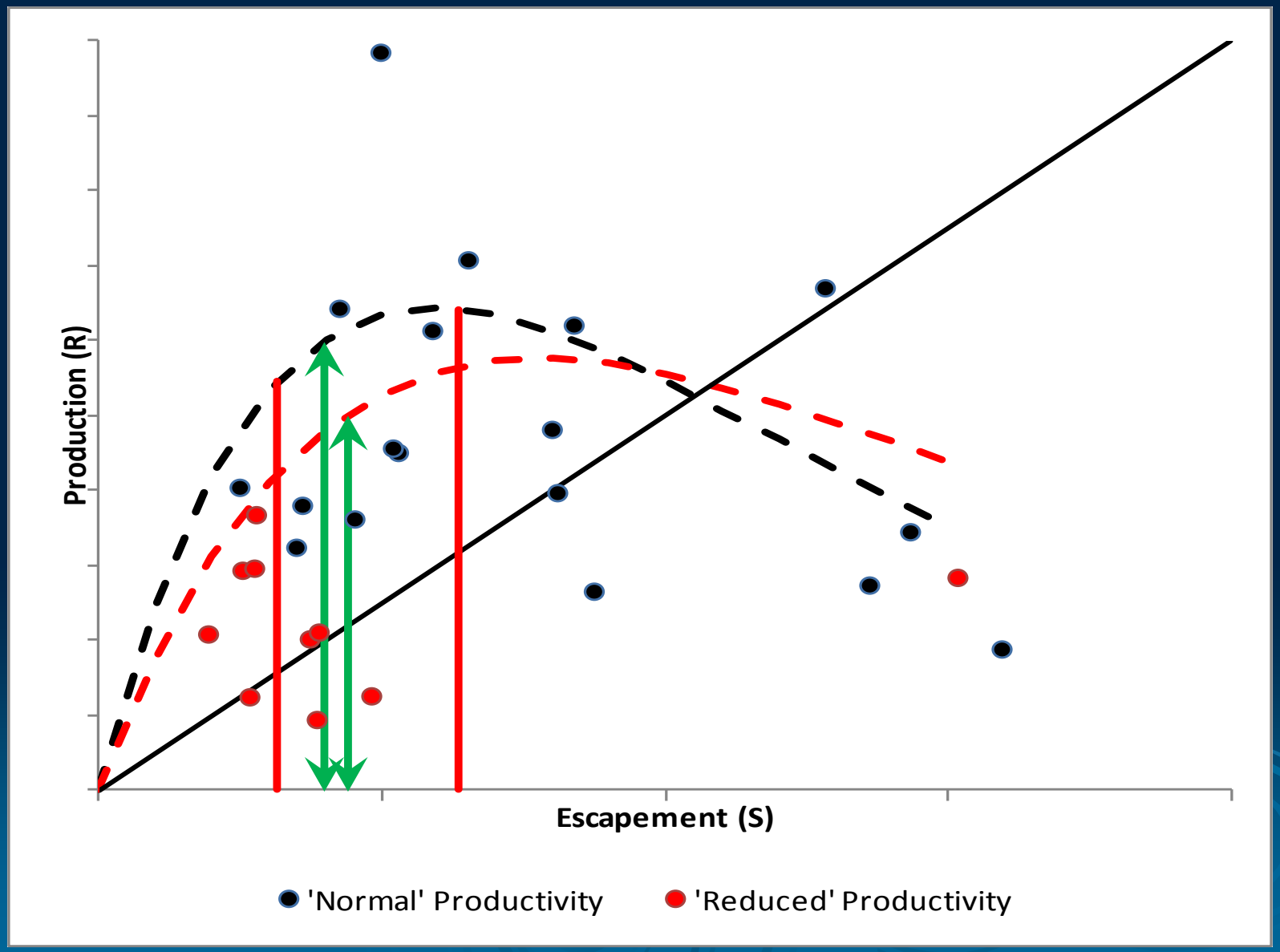
Escapement Goals as Productivity Declines

…but the estimate of S_{MSY} goes up only slightly.



Escapement Goals as Productivity Declines

The original escapement goal should not change as productivity declines.



Why Hasn’t ADF&G used SETs?

Why Hasn't ADF&G used SETs?

- Smallest escapement, below which the stock's ability to sustain itself is jeopardized
  - Escapement levels that result in high probability of extinction of stock
- Only to be used "as needed" for conservation
  - To date they have not been "needed"
- Conceptually difficult to estimate from observations
  - Escapement goal management prevents the observation of very low escapements
  - Need consistent observations at very low escapements

SETs and Jeopardy

- Species effects – average productivity
- Environmental effects – catastrophes
- Demographic effects – individuals
- Depensatory effects – space, time, movements
- Genetic effects – inbreeding

Morris W.F. and D.F. Doak. 2002. Quantitative conservation biology. Sinauer Associates, Inc., Sunderland, MA. 480 p.

SETs and “as needed”

- Since 2000 – 30 stock of concern designations
- Currently 14 stocks of concern
  - 5 yield concern
  - 9 management concern
- Most stocks delisted within 3 to 6 years
  - current stocks of concern most listed 7 years or less

SETs difficult to observe and estimate

- Escapement goal management prevents consistent observation of very low escapements
- Depensatory models need this information to estimate SET
- Proxies for SET require reliable estimates of productivity AND carrying capacity

Roadmap for Presentation

- Review policy framework and processes for escapement goals in Alaska
- Overview of current escapement goal types by region and species
- Concepts and theory of salmon production
- Why and how do escapement goals change?
- How does declining productivity affect escapement goals?
- Why hasn't ADF&G used SETs?