Spawning Potential Ratios (SPR) interpretation and application

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Definition

SPR is:

the ratio of the amount of spawn produced by a cohort of red snapper over its lifespan under a specific fishing regime

relative to

the spawn that would have been produced over the cohort's lifespan if there were no fishing

What do we mean by:

a cohort

amount of spawn produced by a cohort

What do we mean by:

a cohort is a group of fish that are hatched at one point in time

what happens to a cohort over its lifespan?

The fish die from natural causes or fishing, the individuals grow, they mature and they produce eggs.

A cohort can only get smaller in numbers over its lifespan (they only die, no addition/ reproduction)

What do we mean by:

Spawn is the number of eggs produced by a cohort over its lifespan.

In many cases, the # eggs is proportional to the total weight of mature females (spawning stock biomass, SSB), so we use that number instead of # eggs.

For red snapper, we use # eggs but sometimes it is referred to as SSB

Definition

The amount of spawn produced by a cohort with fishing will always be less than the same cohort without fishing

So SPR is

a ratio between 0 and 1

and is usually expressed as a percentage (for example, 30%SPR)

We use schedules of life history parameters at age to calculate SPR

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Example without fishing

	kg	%	Eggs/Female	Mortality (rate)	
	Wt at	Maturity	Fecundity	Natural	Fishing
Age	age	at Age	at Age	at Age	at Age
1	0.35	0	0	0.6	0
2	0.45	10	200,000	0.4	0
3	0.65	50	600,000	0.3	0
.					
‘					
50	2.00	100	1,500,000	0.2	0

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Example with fishing

Age	kg Wt at age	% Maturity at Age	Eggs/Female Fecundity at Age	Mortality (rate) Natural at Age	Fishing at Age
1	0.35	0	0	0.6	0
2	0.45	10	200,000	0.4	0.2
3	0.65	50	600,000	0.3	0.3
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50	2.00	100	1,500,000	0.2	0.3

We use schedules of life history parameters at age

Using these schedules, we can calculate the amount of spawn with and without fishing and calculate its ratio SPR

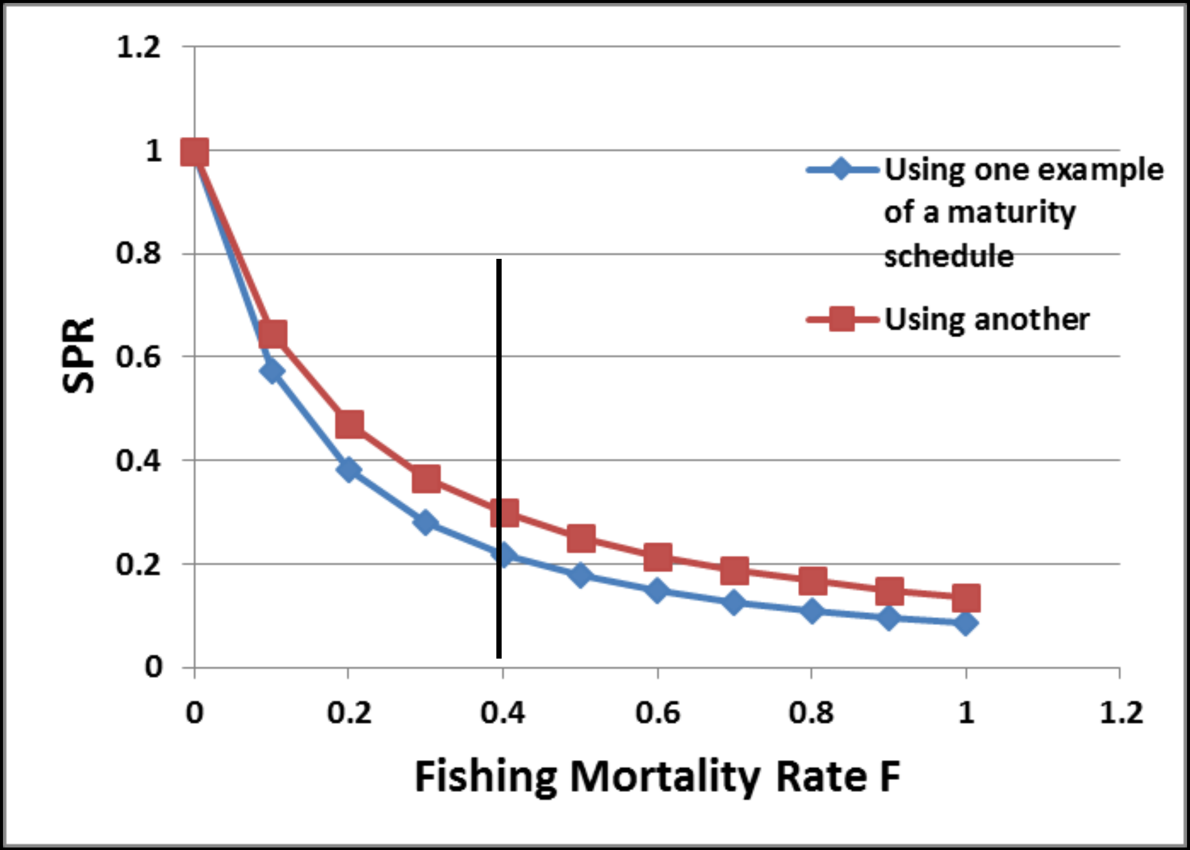
Advantage only life history/fishing data is reguired. Don’t need recruitment because it’s a ratio and cohort strength (recruitment) cancels out.

But this is longterm, which is what we mean by doing the calculations over the lifespan of the cohort (the cohort is in equilibrium)

So changing the rate of fishing (F) and/or the fishing schedule across ages will change SPR.

Often we refer to the notation Fxx%SPR as the rate of fishing that will reduce the SPR ratio to xx%

When we plot SPR vs fishing mortality rate F, we get plots that look like this:



In this example SPR of 30% occurs at an F of about 0.4 (F30% SPR = 0.4)

For any year in which we do an assessment, we can calculate the life history schedule and thus the SPR for that year's rate of fishing

However, that SPR is not the amount of spawn produced during that year;

it is the amount of spawn that would be produced if that fishing rate were continued over the longterm;

So under these circumstances, SPR is an indicator of relative changes in fishing rates and not an indicator of the size of the SSB

Therefore, what is meant when the objective is to recover to 26% SPR within the allowable recovery period?

(recovery period is 1 generation + the amount of time for rebuilding with no fishing; in the case of red snapper this is ~ 32 years starting in the year 2000)

In a recovery the fishing mortality rate is reduced and the SSB starts to get larger. Then "recovery" is the SSB that would produce MSY.

Therefore, what is meant when the objective is to recover to 26% SPR within the allowable recovery period?

When we use (for example) F26% SPR as the proxy for FMSY, then by analogy, the spawning stock biomass that would would occur is the SSB that would occur if F26% SPR

were kept in place for a long time

Then we judge the current SSB relative the SSB that would arise from F26% SPR and depict it by the ratio $SSB_{current}/SSB_{F26\%SPR}$. A ratio > 1 good; < 1 bad

Therefore, what is meant when the objective is to recover to 26% SPR within the allowable recovery period?

We use a recovery period based on generation time because it will take a number of years for the effects of changes in F to percolate through the age distribution …. through the life history schedule

But remember that recovery also depends on the number of recruits that are produced, which are only indirectly related to changes in F.

The theory is that decreased F’s will increase SSB which, in turn, will increase the chances of good recruitment

How is SPR used in assessments?

Recall, the assessment is required to give you the yield (catch in wt) that we get at a fishing mortality rate (F) that will result in maximum sustainable yield over the longrun (or FMSY)

But often FMSY is difficult to measure directly because it depends upon the recruitment history of the stock.

However, Fxx% SPR is still calculatable since it only relies on the life history schedules at age

What is the most appropriate Fxx%SPR?

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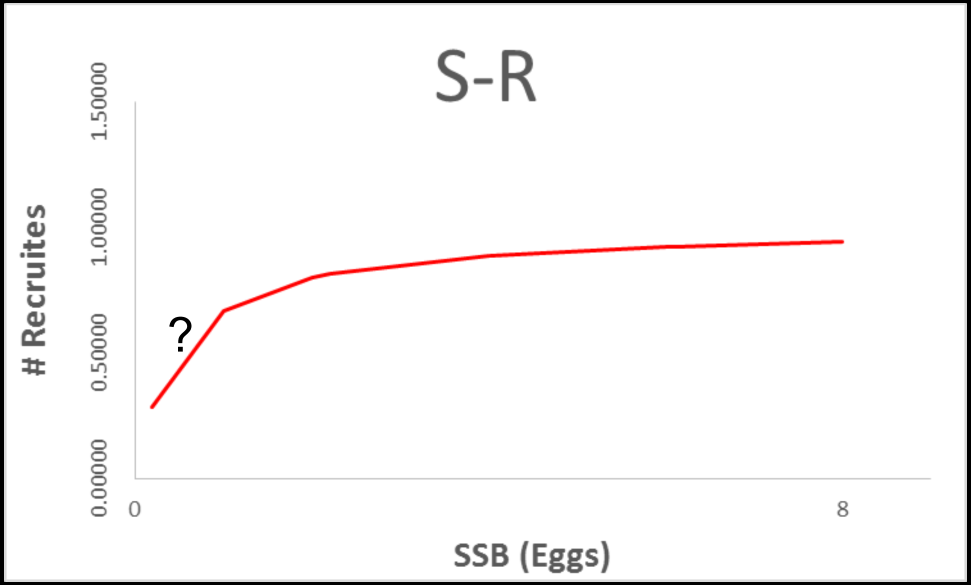
This depends heavily on life history parameters

But using observations on other stocks and by doing many simulation analyses, scientists have found that FMSY is often in the range of F20%SPR and F40%SPR.

Therefore, in circumstances where FMSY is poorly estimated, scientists will use, for example, F30%SPR as a proxy for FMSY. The choice of 30% or some other percentage depends upon the life history schedules

How is SPR related to reproductive success and the stock recruitment relationship (S-R)?

Theory says that at lower SSB's there will be lower recruitment…. But how much?



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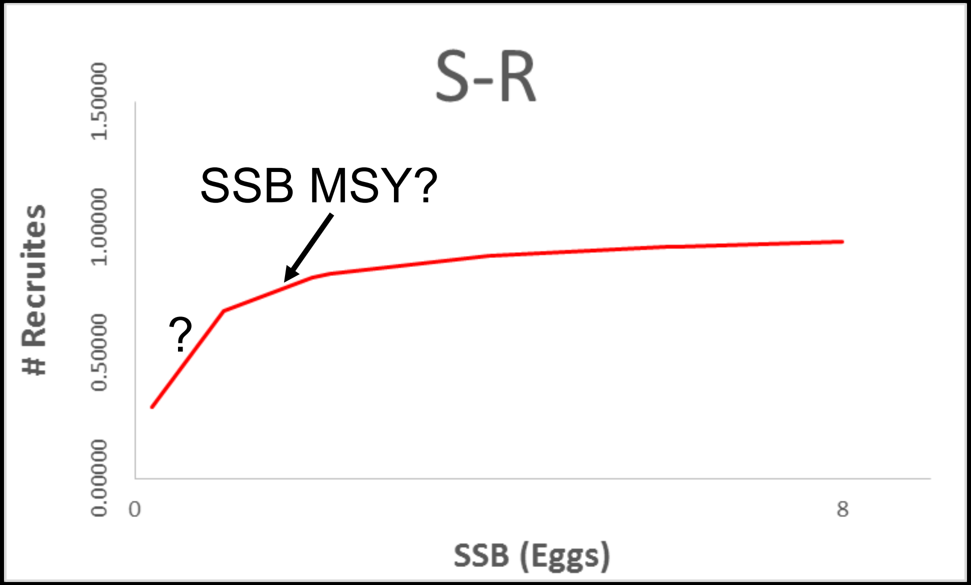


Simulations show that SSB at MSY is above where recruits start to decline

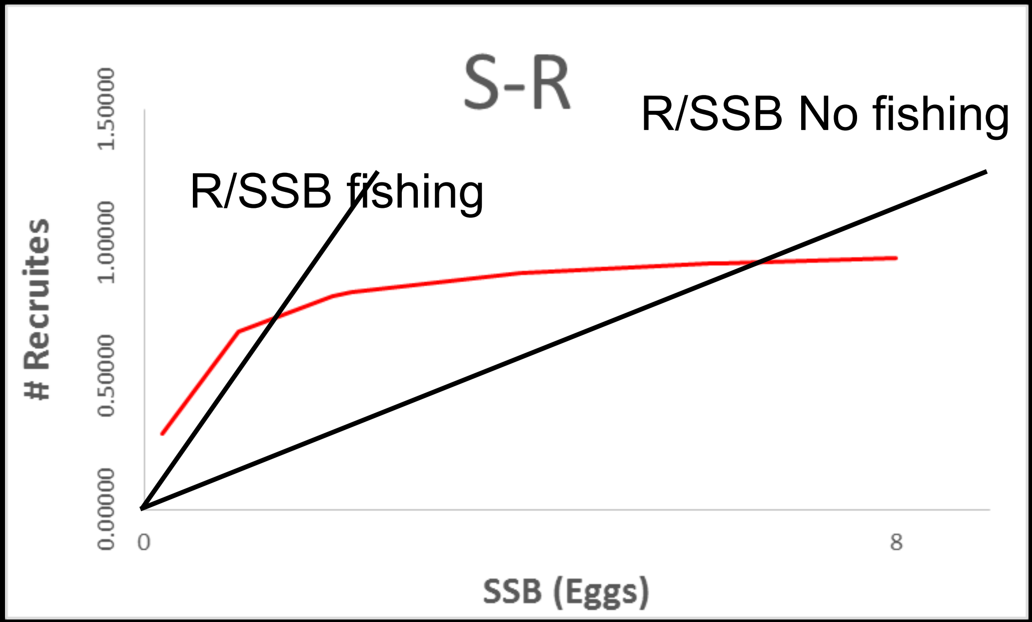
How is SPR related to reproductive success and the stock recruitment relationship (S-R)?

We can plot SPR on an S-R graph: remember

SPR= S per R with fishing /S per R without fishing

Or

SPR= R per SSB without fishing/ R per SSB with fishing



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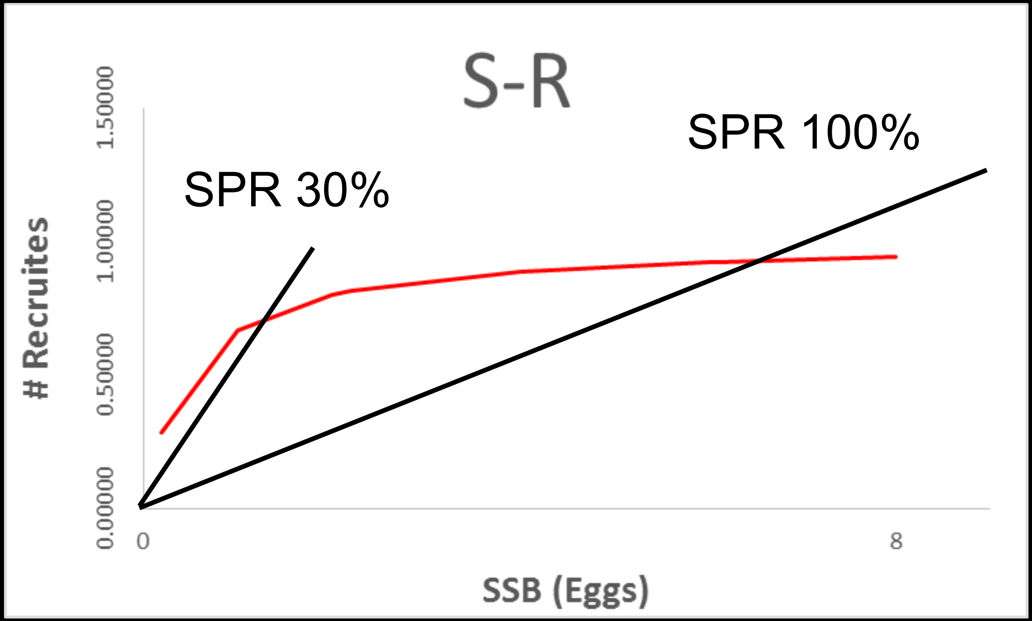

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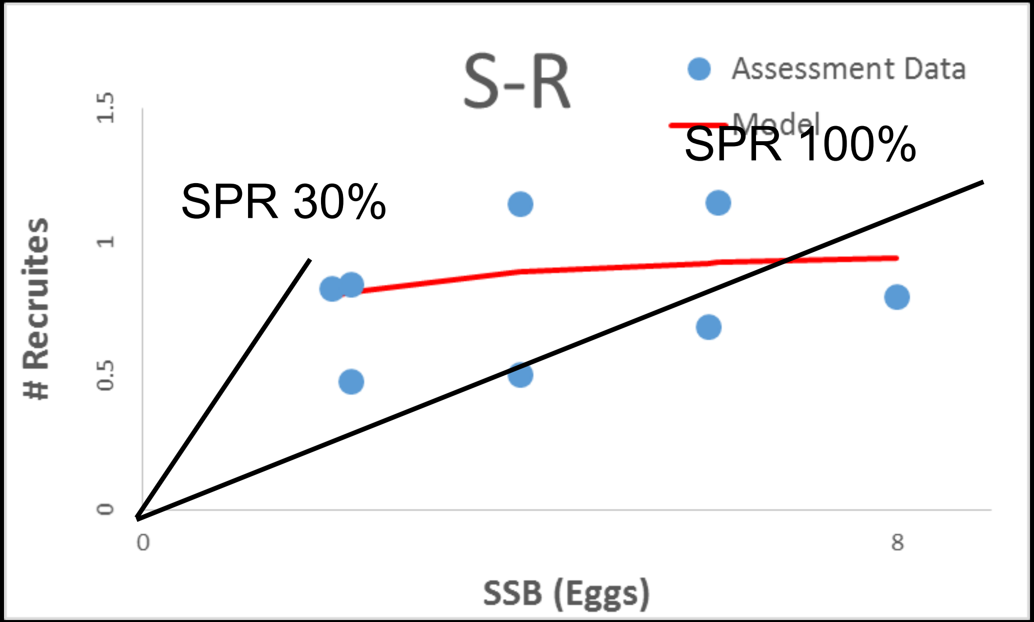
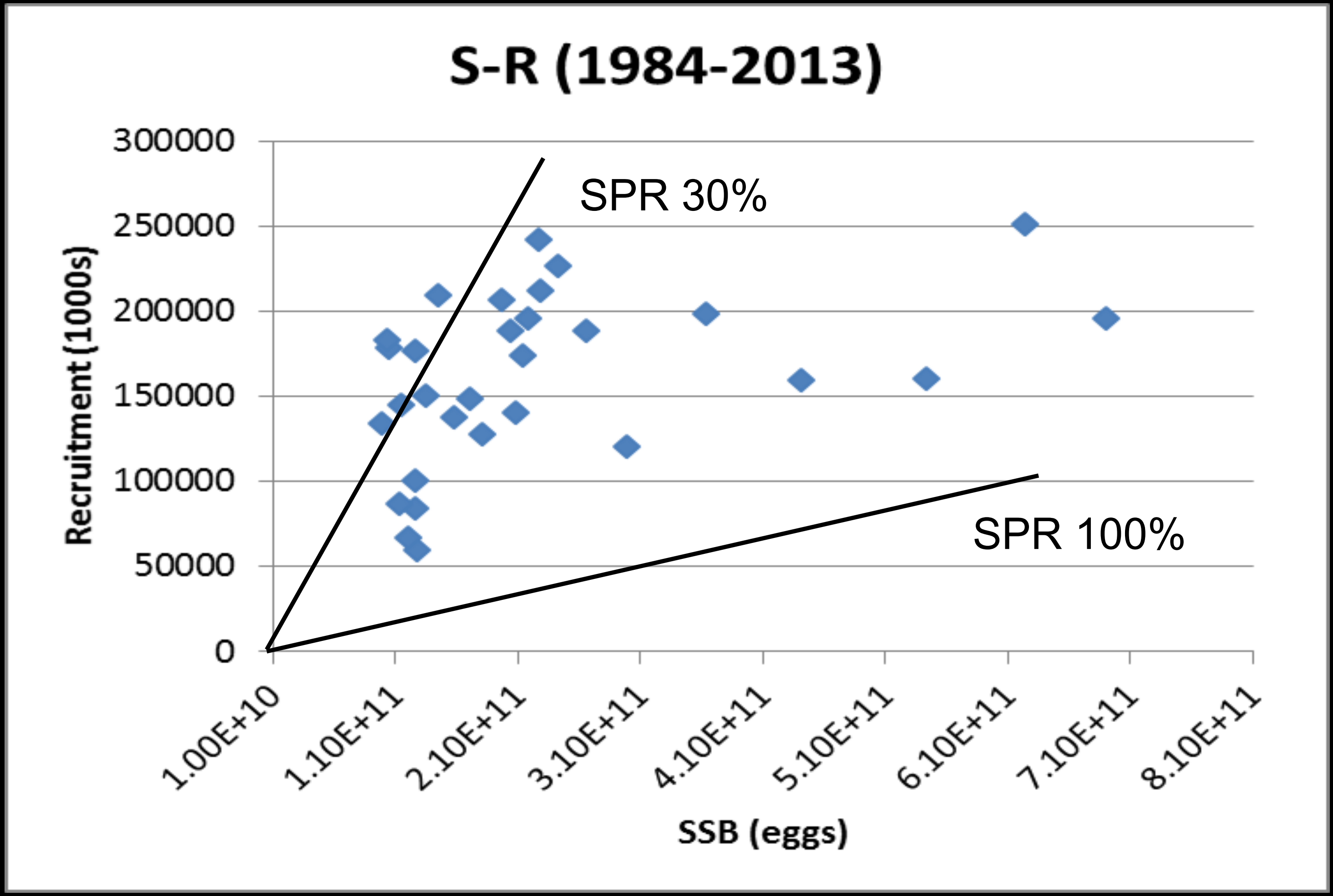


Red snapper
Stock-Recruitment S-R



Take Home Thoughts

F26%SPR is used as a proxy for FMSY

Recovery to SPR 26% means recovery to the SSB that would support an SSB of 26%. This is a proxy for SSBMSY.

A change in SPRMSY or SPR26% isn't expected to occur unless there is some change in our knowledge, such as new studies on fecund

Year to year changes in SPR are reflective of changes in F from year to year, rather than changes in spawning biomass