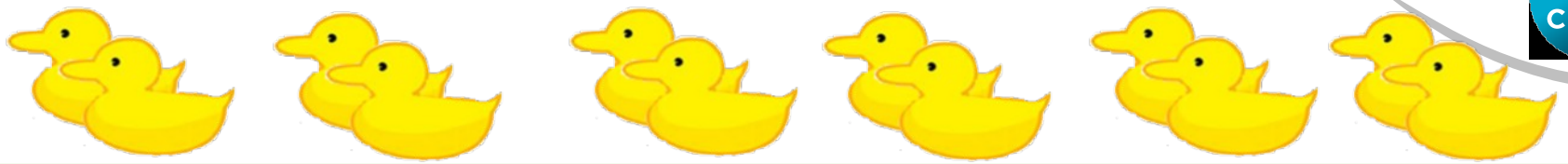
Fish: the whole shebang
Southern Sweetlips

Mark Bravington, CSIRO: June 2021

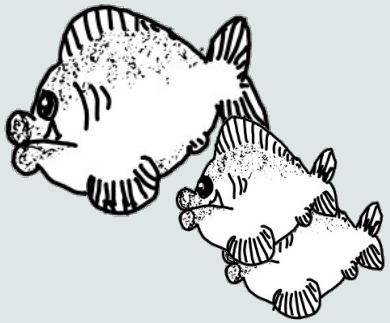


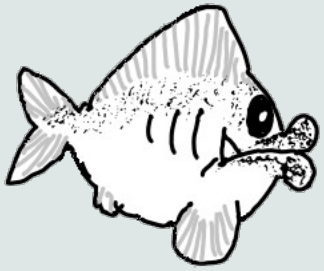
POPs+HSPs: Southern Sweetlips *Notogorgius poutii*

1. Fecundity strongly size-dependent

2. Catch (@age) mostly adults,

   some juves





3. Constant *m* in ages caught

4. *For demo:* assume

   i age known, age not length is driver of fec, sel

   ii only females used/modelled

   iii constant recruitment really, *mean* recruitment might be constant, but cohorts vary

5. Non-equilib incl. changing sel during study

6. Also selection for CKMR sampling

What does CKMR tell you?

To get quantitative estimates: **use a proper model, properly**

But to understand why it all works, it's OK to simplify...

POPs:

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- TRO (Total Reproductive Output):

  EG 5yo ♀ adults might give 6 POP in 12,000,000 comps in 2020

  so $TRO_{\circ\,2020}$ ~= 2,000,000 equiv 5yo♀

- ∠
- Age composition of adults

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  NB **both** TROs refer to same adults: what are the units ?!

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  NB **both** TROs refer to **same** adults; what are the units ?!

NO information on:

- Z
- Age composition of adults

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POPs:

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- TRO (Total Reproductive Output):

EG 5yo ♀ adults might give 1 POP per 10,000,000 comps in 2020

so $TRO_{♀,2020}$ = 10,000,000 equiv 5yo♀

what are the units of TRO ?!

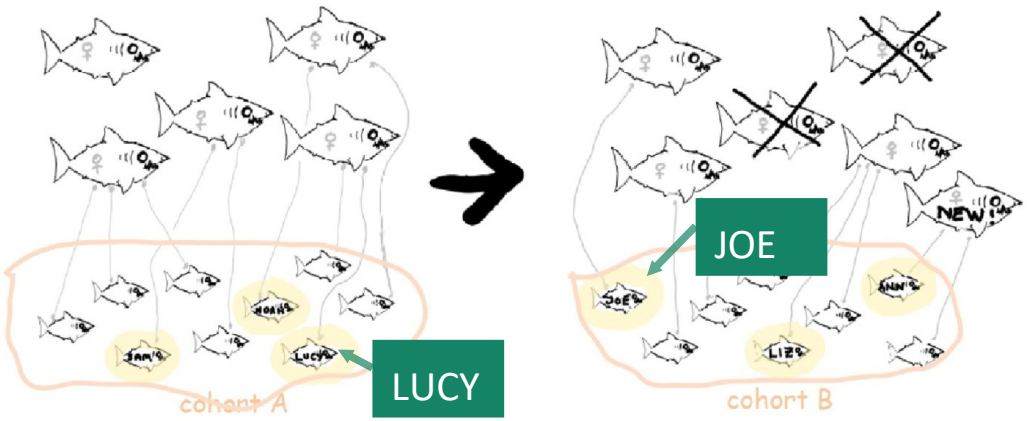
If all adults by sex have same fecundity, TRO *is* adult abundance

EG many sharks, mammals

so POPs alone can tell you N and TRO (but not Z)

- Z
- Age composition of adults

What does CKMR tell you?



Pr[Joe is Lucy's YHSP]

HSPs *cross-cohort*:

- Z: longer birth-gap => lower chance Lucy's mum survived

but if she did, then she also grew...

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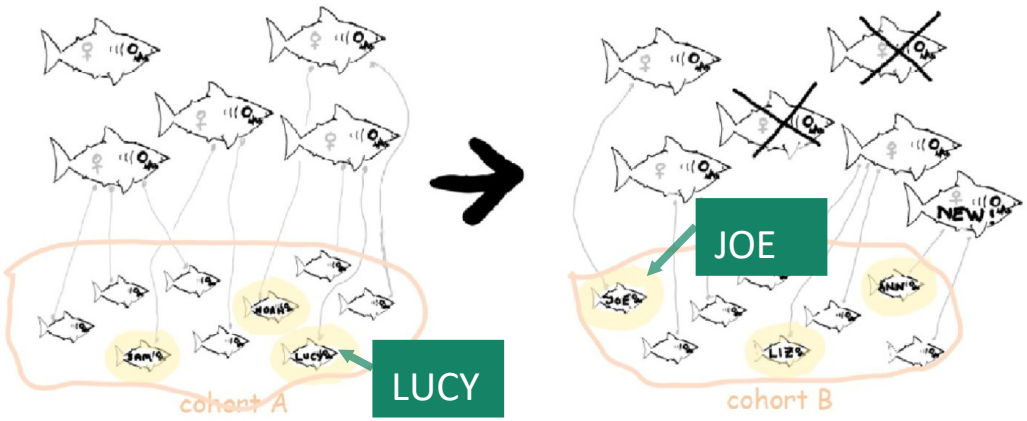

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- Some abundance signal : bigger N => less chance of HSP

but, strongly affected by adult age composition; not N, not TRO

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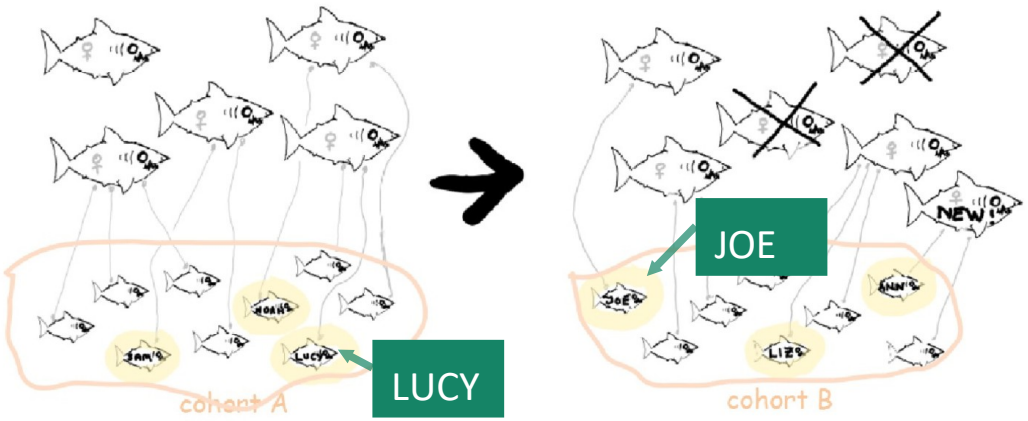

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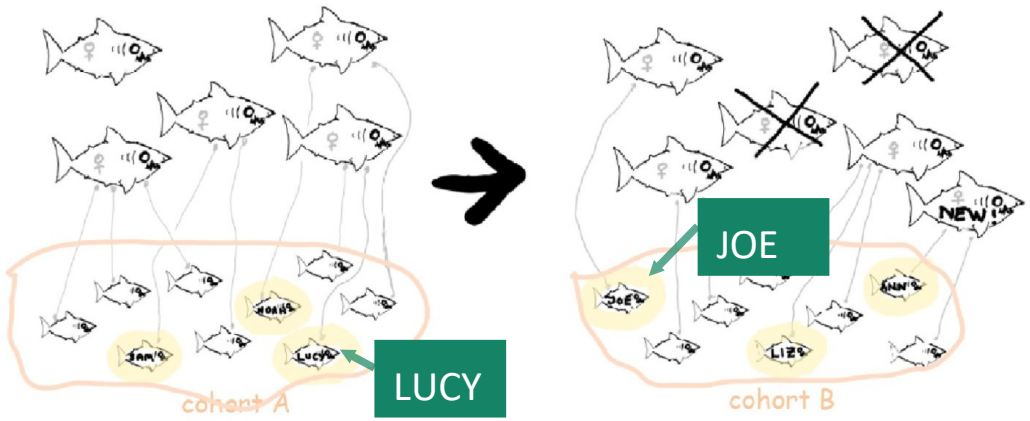

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If all adults by sex have same fecundity, eg many mammals & sharks

then juvenile HSPs alone can tell you N *and* Z

(needs fairly good age info)

Same-cohort: No useful info; *exclude same-cohort comps*

What does CKMR tell you?

Neither POPs-alone nor HSPs-alone is enough for fish*

But *together* they can ***do it all***!

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Everything that's needed for F-based management, eg SPRR

(except direct info on juves--- but may not be needed)

Transparent model; data cannot be manipulated

No need for dubious CPUE or assumptions about selectivity

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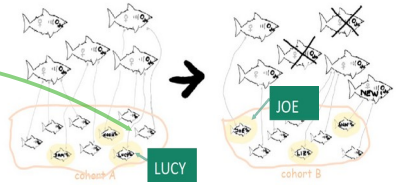
Recap of the ideal



Juves:

only **age** matters (and mixing...)

For **Older HS**: immature, or just mature

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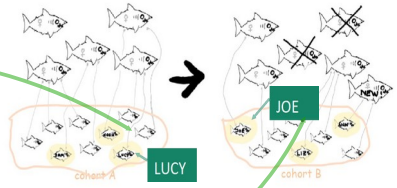

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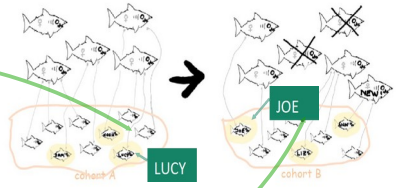

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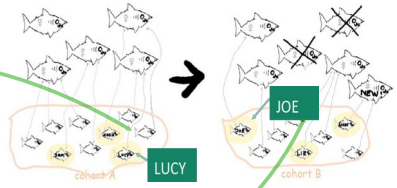

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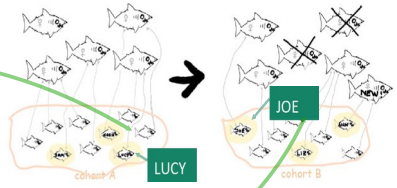

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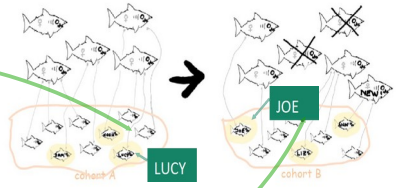

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Uncertainty in age not so important

CKMR for “fish”: what do you need / get ?

"Executive"-level summary

POPs: tell you *N* or SSB

HSPs: tell you *Z*

NB: only for adults; back-dated to juvenile birth

"Useful" kin: usually AJ POPs, and JJ HSPs

That's **too simple !** except for executives

- You **do** need both POPs and HSPs to get N_{adult} ; SSB; trend; $\bar{z}_{adult}$
- ... by sticking it all into a (the!) model
  - and if you know C_a then you get *m* as well

CKMR for "typical fish": what do you need?

For "mammals", short-cuts sometimes OK. Not for teleost fish...

POPs

- **Rel fec at size** (♂ too)
- **"SSB"**
- [Trend]

but *not*:

- ~~age compo~~
- ~~mort rate *z*~~

HSPs

- Adult **mort rate** *z*
- **Mean age** of adults
- [Trend]

but *not*:

- ~~SSB~~ (well, not *exactly*)
- ~~fec-at-size~~

* Length, sex, (age)
* Genotypes

* (Catch-at-age)

- Mean adult age
- "SSB"
- *z* (average adult) or *m*
- Fec-at-size

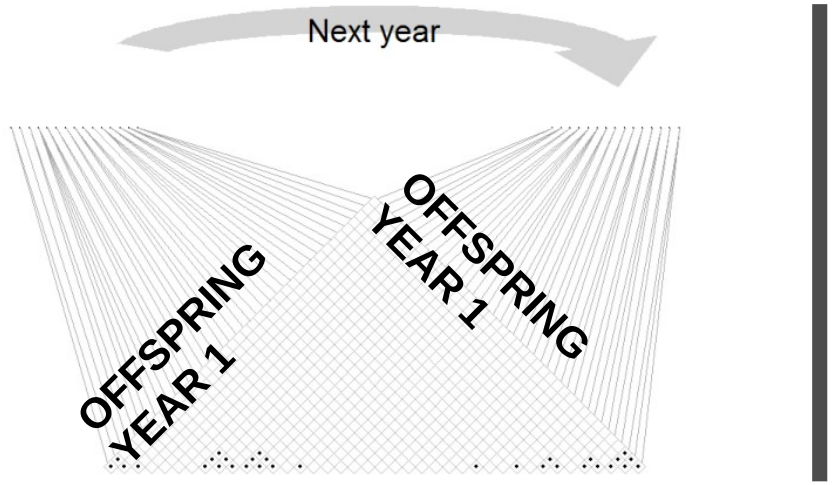
What else do you want ?!

~~CPUE~~
~~length freqs~~
~~surveys~~

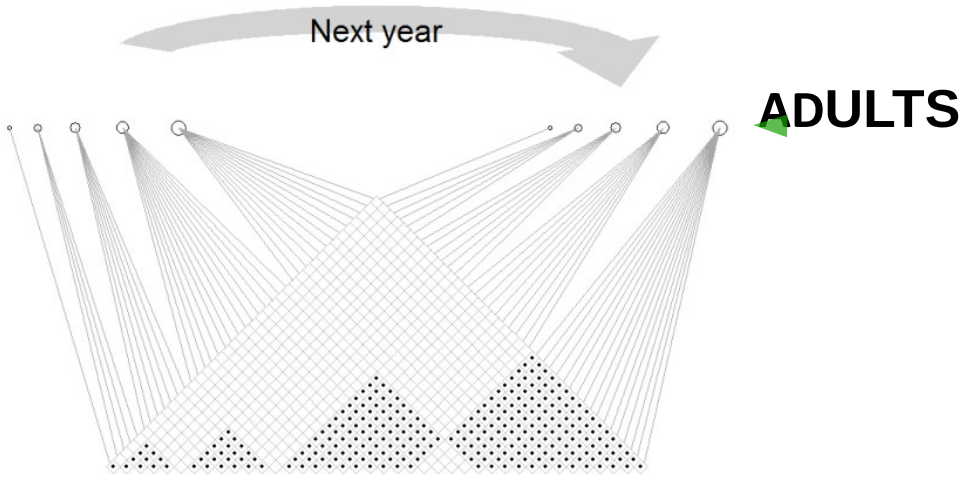
What do HSPs tell you ?

- Time-gaps between birth => adult survival ie *Z*
- Abundance: nothing much

  (unless all adults are similar, eg some mammals and sharks)



Scenario 1: lots of *young* adults



Scenario 2: fewer adults, but older

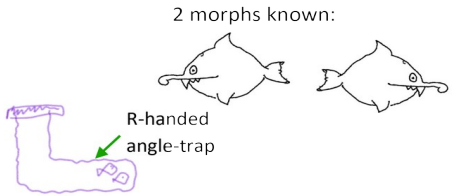
- Both scenarios have same TRO and same fec-at-age
- but very different numbers of HSPs
- "short-gap"-HSPs-to-POPs ratio: mean adult age;
- "long-gap"-to-"short-gap" HSP ratio: adult Z

What does CKMR *really* tell you?

Each *type* of comparison => N_{equiv}

POPs: Pinocchio's Dolphin *Delfinus mendax*

#2 Bilateral Bay
Juves & adults
Age known from teeth
Age-selective sampling
Angle-trap fishery: *chirality*

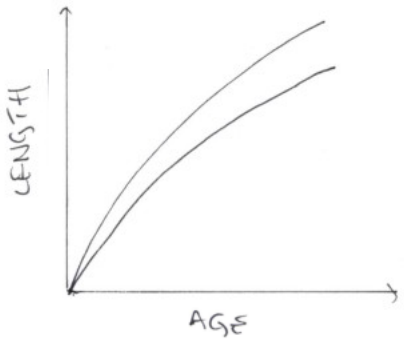


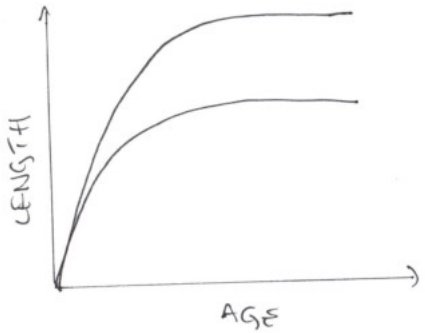
Takehomes: Bilateral Bay

1. Heritable "quirk" can cause bias if ignored
   - if affects ju **&** ad sampling probs

Fish: is an aged-based model enough ?

1. Length not age the main driver (reprod, selectivity)
2. Age uncertain, use Pr[Age|Length]. ¿ Fec[A] or Fec[L] ?
    1. POP bias: selectivity corr'd with RO, even *given* age
    2. HSP bias: RO corr'd over time, even *given* age





Age-driven models *are* simpler: does the bias matter?

¿ Not for design ? But... yes it can, for real data