



POPs: Pinocchio's Dolphin



Mark Bravington, CSIRO: June 2021

O&A
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POPs: Pinocchio's Dolphin *Delfinus mendax*

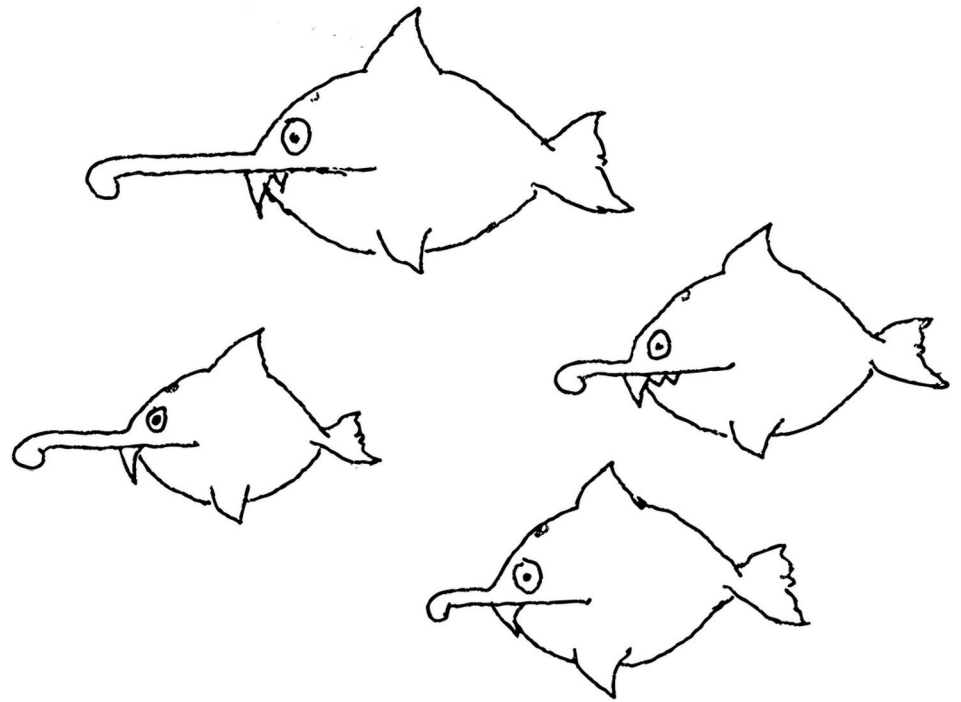
Several distinct populations

High bycatch ~20y ago

Less now: any recovery?

CKMR samples ~10y

Biology / sampling: listen!



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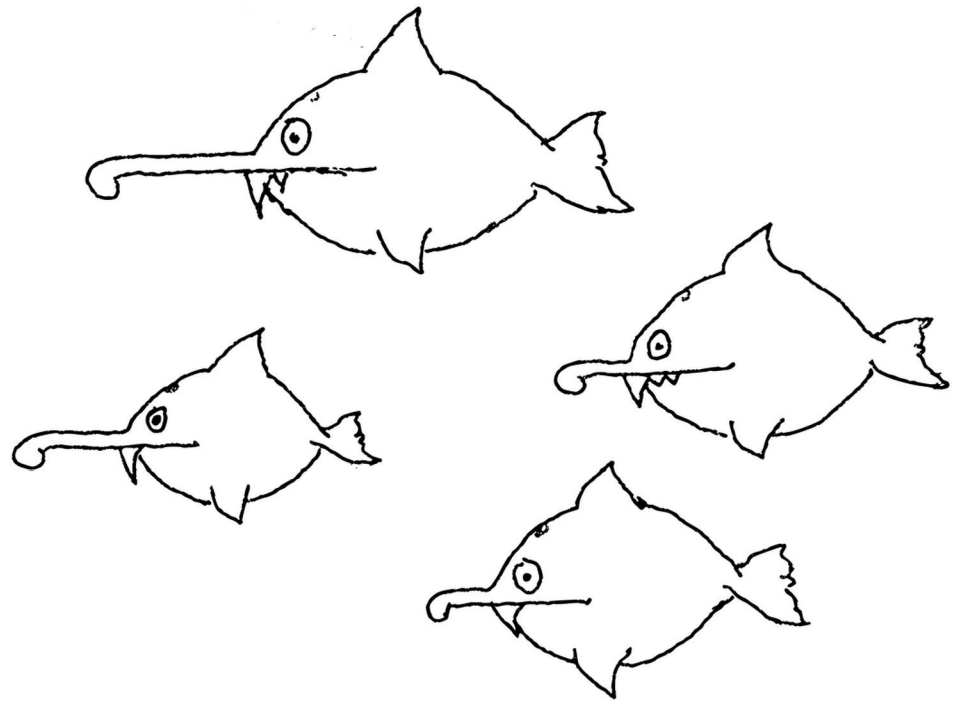
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$$N_{t+1} = N_t e^{\lambda t}$$

RoI : λ

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#1 Acme Archipelago

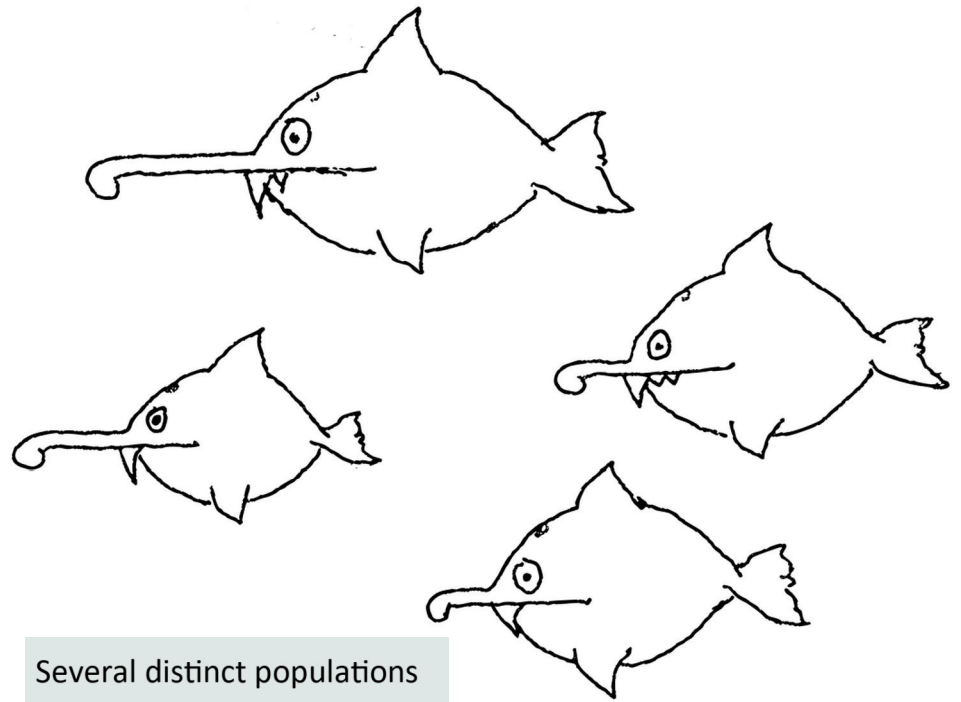
Juvs & adults

Age known from teeth

Age-selective sampling

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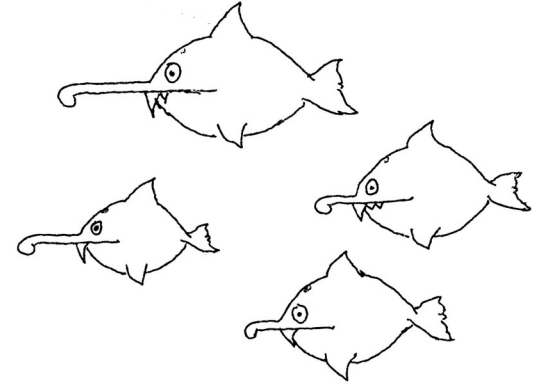
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POPs: Pinocchio's Dolphin *Delfinus mendax*

NB only *female* samples
used in these models
(for brevity)



What is kinship prob? Via ERRO...

$$\mathbb{P} [\text{Amy is Jill's mum}] = \mathbb{E} \left[\frac{\# \text{Amy's offspring @ Jill's birthyear}}{\text{Total \#off. @ J's } b} \right]$$

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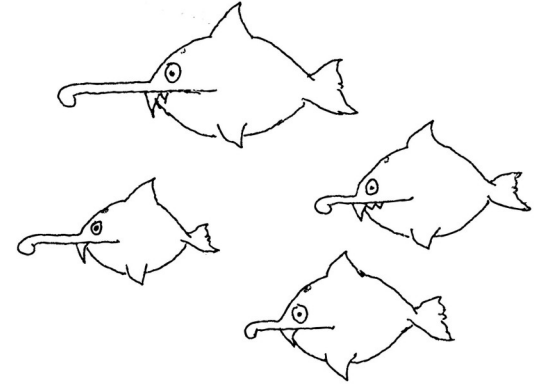
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For equation lovers:

$$\begin{aligned}\mathbb{P} [\text{Amy is Jill's mum} | \text{facts about A \& J}] \\ &= \mathbb{P} [K_{AJ} = \text{MO} | b_J, y_A, a_A] \\ &= \frac{\mathbb{I} [b_J < y_A] \times \mathbb{I} [a_A - (y_A - b_J) > \alpha]}{N_{\text{♀}b_J}}\end{aligned}$$

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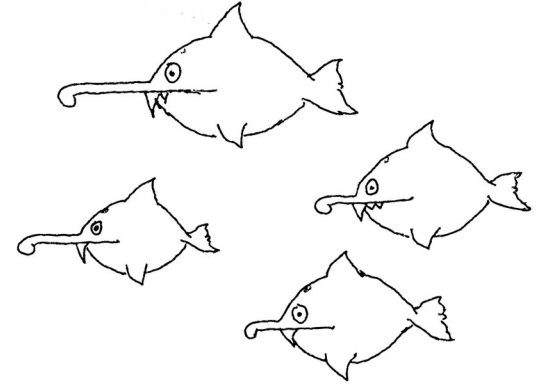
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Takehomes from Acme Archipelago

1. Very easy --- ideal data!

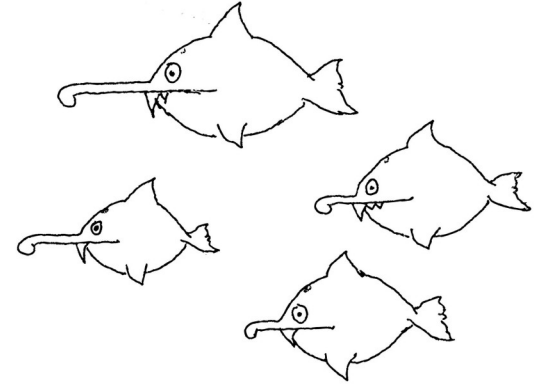
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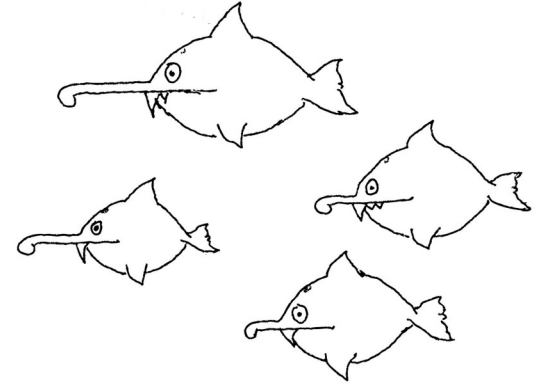
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 - (Anything about juvs)

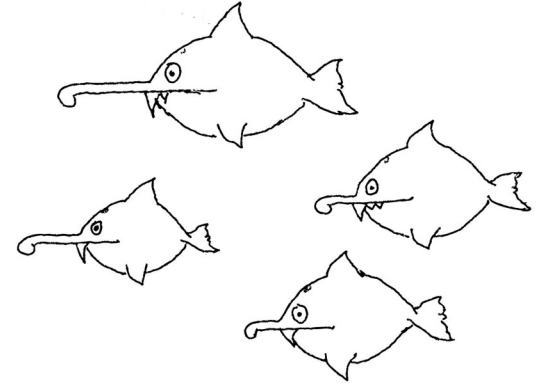
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Takehomes from Acme Archipelago

1. Very easy --- ideal data!
2. No point to “index”-- fit a model
3. What's *not* there?

- (Anything about juves)
 - Mortality
 - Selectivity
 - Age compo
- } for adults

$$\begin{aligned}\mathbb{P} [\text{Amy is Jill's mum} | \text{facts about A \& J}] \\ &= \mathbb{P} [K_{AJ} = \text{MO} | b_J, y_A, a_A] \\ &= \frac{\mathbb{I} [b_J < y_A] \times \mathbb{I} [a_A - (y_A - b_J) > \alpha]}{N_{\text{♀}b_J}}\end{aligned}$$

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#2 Bilateral Bay

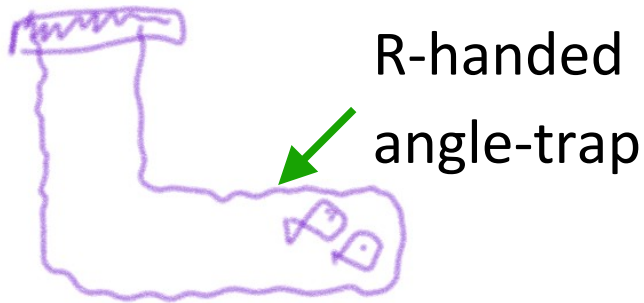
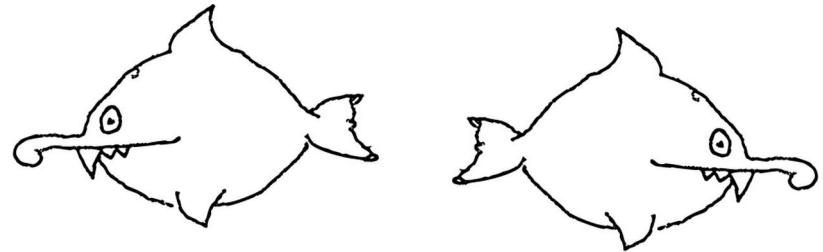
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Age known from teeth

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Angle-trap fishery: *chirality*

2 morphs known:



$$N_{t+1} = N_t e^{\lambda t}$$

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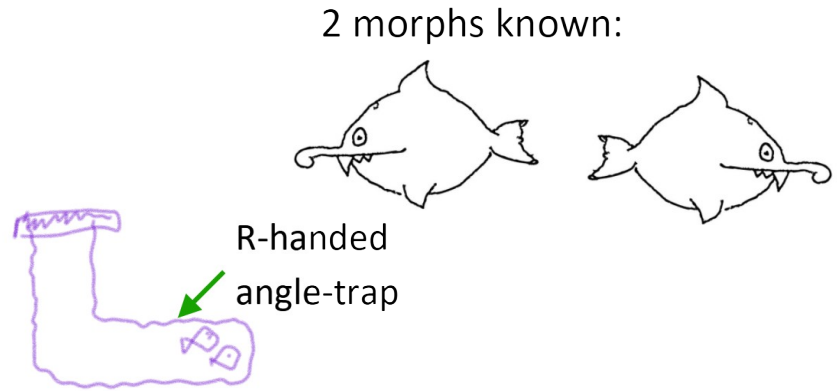
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Check ERRO condition for *naive* model:

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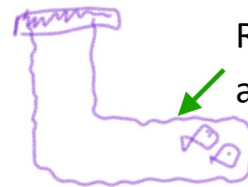
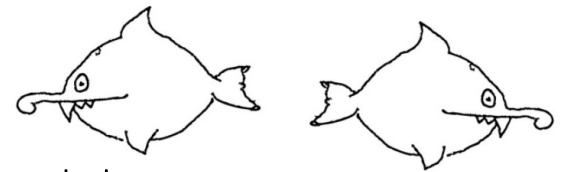
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R-handed
angle-trap

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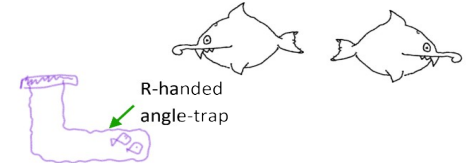
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Amy's ERRO re Jill:

$$\mathbb{P} [K_{AJ} = \text{MO}]$$
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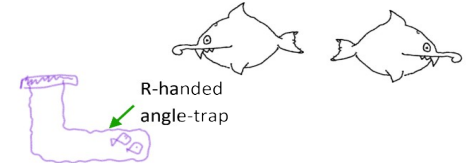
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J was sampled

ie caught in R-h trap

A was sampled

ie caught in R-h trap

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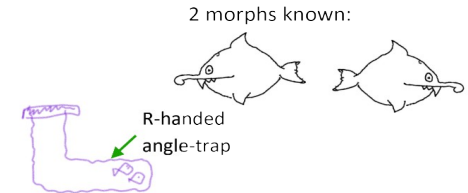
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J's handedness

A's handedness

The equation is annotated with purple circles and lines. A circle around 'J-like' in the denominator is connected to 'J's handedness'. A circle around 'stuff about A' is connected to 'A's handedness'.

Best to *condition* on handedness (and measure it!)

POPs: Pinocchio's Dolphin *Delfinus mendax*

$$\mathbb{P} [K_{aj} = \text{MO} | H_a H_j]$$

= ...

$$= \frac{\mathbb{P} [H_j | H_a, \text{MO}]}{N_{\text{♀}} \mathbb{P} [H_j]}$$

(ignoring alive/mature check for now)

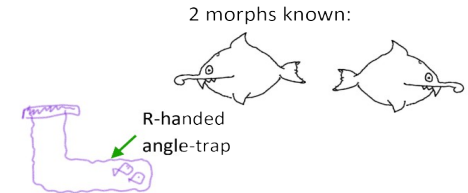
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$$= \frac{\mathbb{P} [H_j | H_a, \text{MO}]}{N_{\text{♀}} \mathbb{P} [H_j]}$$

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$$\mathbb{P} [H_j | H_a, \text{MO}] =$$

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From Mendelian theory for
recessive gene with freq p :

Handwritten Punnett square for a recessive gene with frequency p :

	L	H ₀
L	$1 - \frac{p^2}{1+p} = \frac{1+p-p^2}{1+p}$	
R		$\frac{p^2}{1+p}$
	$1-p$	p

A green arrow points from the text 'From Mendelian theory for recessive gene with freq p :' to the Punnett square.

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 - if affects ju & ad sampling probs



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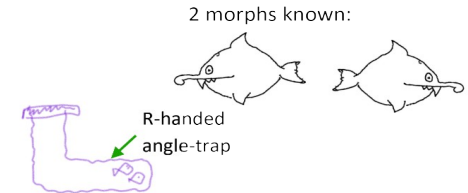
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 - & can relate sample freq to popn freqie “sample selectivity”



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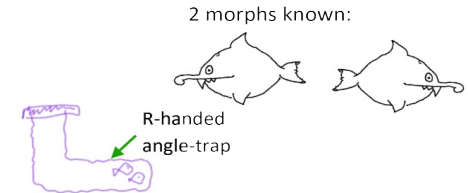
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Takehomes: Bilateral Bay

1. Heritable “quirk” can cause bias if ignored
 - if affects ju & ad sampling probs
 - Needed careful choice of sim params to get big effect...
2. Fixable--- *if*:
 - we measure it!
 - & can relate sample freq to popn freq
 - ie “sample selectivity”
3. Ignore biology at your peril--- but avoid paranoia

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#3 Coast of Confusion

Juvs & adults

Age known from teeth

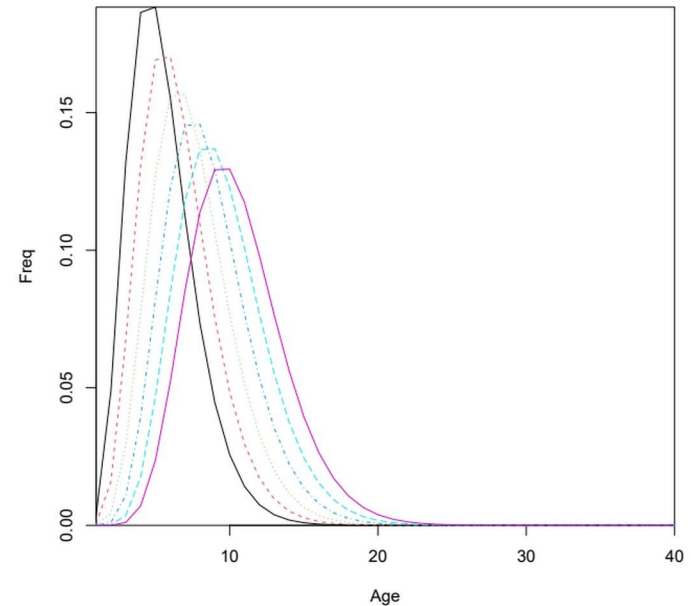
Age-selective sampling

Adult age *imprecise* (but unbiased)

Juve age fine

“Pyrolytic Enfumeration”

Ageing noise: Coast of Confusion, true 5--10yo



$$N_{t+1} = N_t e^{\lambda t}$$

RoI : λ

Several distinct populations

High bycatch ~20y ago

Less now: any recovery?

CKMR samples ~10y

Biology / sampling: listen!

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Will this mess up naive ERRO?

Yes!

Explain why :)

“Pyrolytic Enfumeration”

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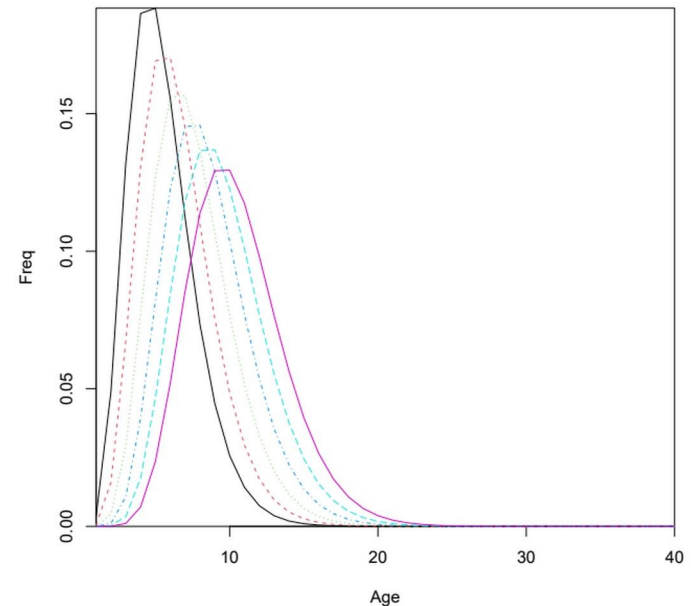
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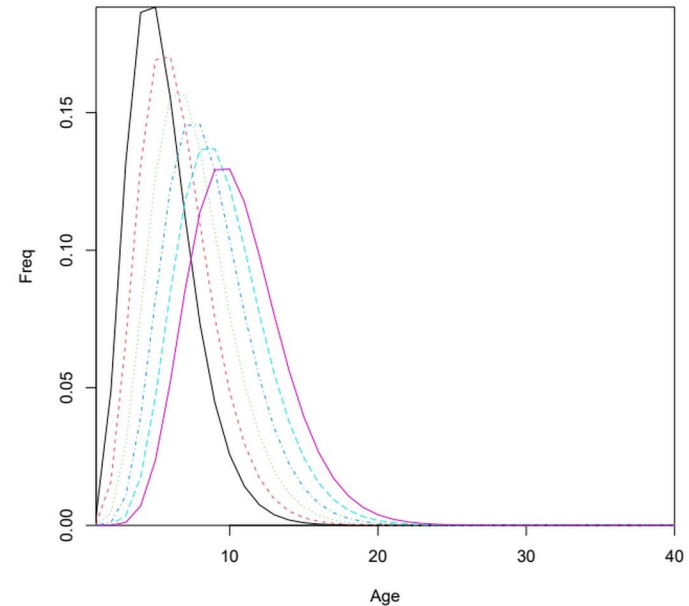
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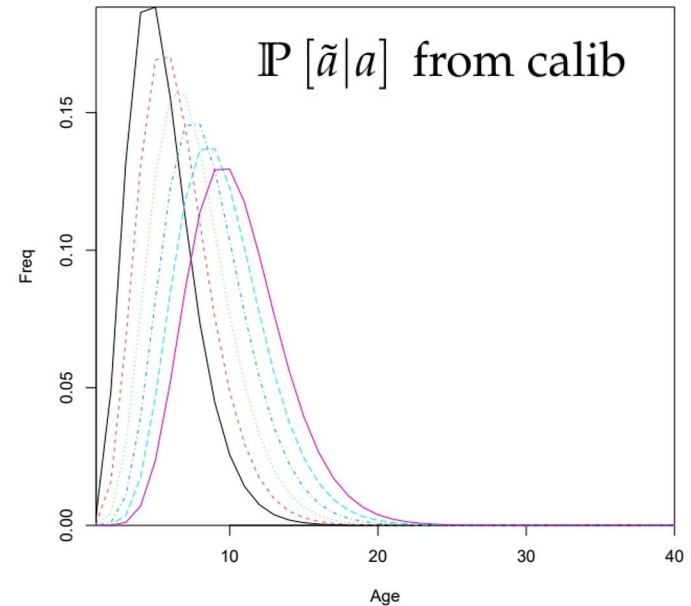
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$$= \sum_{a_A \geq \alpha} \mathbb{P}[\text{MO} | b_J a_A y_A] \times \mathbb{P}[a_A | \tilde{a}_A y_A]$$

formula known

how?

$\mathbb{P}[\tilde{a}|y]$ from samples ... and Bayes' theorem

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“Pyrolytic Enfumeration”

Deconvolution:

recover signal from noisy data

Used to be “very hard”

Now just “hard”

I had to write an R package for this:

`deconvodisc`

using TMB and `mgcv`

I've *ignored* uncertainty from deconvo:

coulda/shoulda either

- embed deconvo in `lglk`, or

- “varprop”

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$$\mathbb{P} [\tilde{a}|a] \checkmark$$

$$\mathbb{P} [\tilde{a}|y] \checkmark$$

$$\mathbb{P} [a|\tilde{a} y] ?$$

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Takehomes: Coast of Confusion

1. Noisy *adult* covariate eg age
 - bias if ignored (tho' I had to try hard)
 - fixable *if* calibration known
 - moderate PITA
2. Will affect Variance (# meaningful comps now uncertain)
3. What *really* drives sel prob / ERRO ..?

“Pyrolytic Enfumeration”

#3 Coast of Confusion

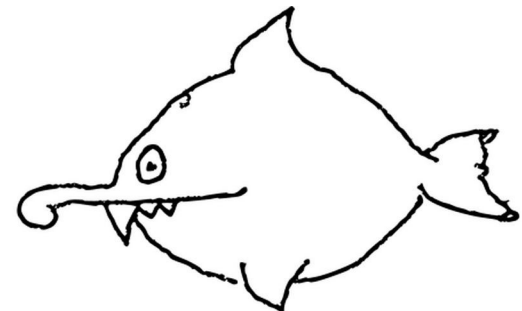
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#4 Dismal Delta

Juvs & adults

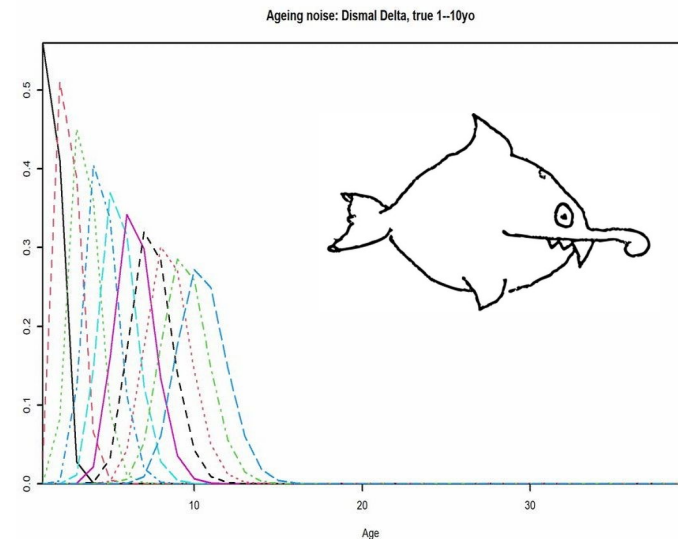
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Ad & juve ages *noisy* (but unbiased)

True juve ages were lost!

“Pyrolytic Enfumeration”



Was Amy alive-and-mature when Jill was born? *We can no longer be sure...*

and we aren't even sure *when* Jill was born :/

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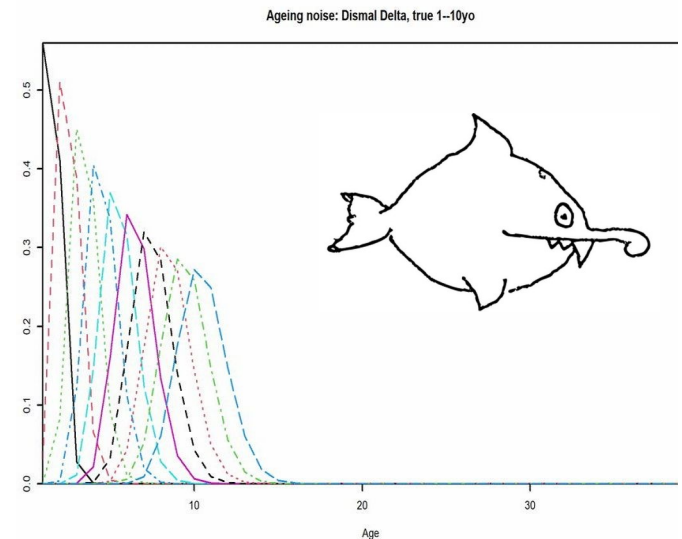
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and we aren't even sure *when* Jill was born :/

and is it K=MO or K=OM ?

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"Pyrolytic Enfumeration"

$$\begin{aligned}
 & \mathcal{P}(K | f_1, f_2, y_1, y_2) \\
 &= \sum_{z_1} \sum_{z_2} \mathcal{P}(\overset{\text{OM}}{\text{MO}} | z_1, y_1, z_2, y_2) \\
 & \quad \mathcal{P}(z_1 | f_1, y_1) \mathcal{P}(z_2 | f_2, y_2) \\
 &= \sum_{z_1} \sum_{z_2} (\mathcal{P}(\text{MO} | z_1, y_1, z_2, y_2) + \mathcal{P}(\text{MO} | z_2, y_2, z_1, y_1)) \\
 & \quad + \mathcal{P}(z_1 | f_1, y_1) \sim \mathcal{P}(z_2 | f_2, y_2) \\
 &= \sum_{z_1} \sum_{z_2} \mathcal{P}(\text{MO} | y_2 = y_2 - z_2, z_1, y_1) + \mathcal{P}(\text{MO} | y_1 = y_1 - z_1, z_2, y_2) \\
 & \quad \text{---} \quad \text{---}
 \end{aligned}$$

EITHER

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"f" is Fuzzy age, ie \tilde{a}

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Takehomes: Dismal Delta

1. Noisy *juve* age
 - bias if ignored
 - fixable^{ish} *if* calibration known
 - must truncate data & time-range
 - big PITA
2. Blurring of kinships: MO & OM
3. ? Bad effect on Variance (especially trend) ?

“Pyrolytic Enfumeration”

#4 Dismal Delta

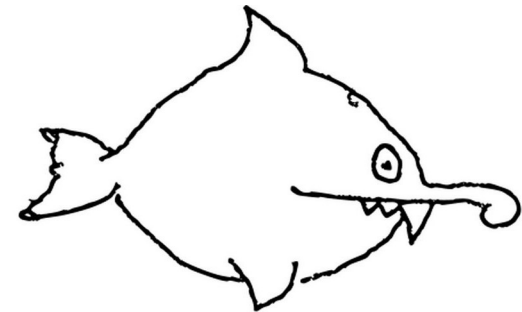
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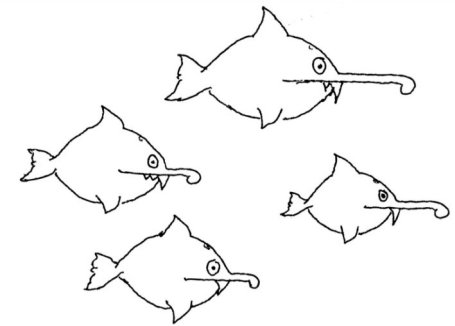
True juve ages were lost!



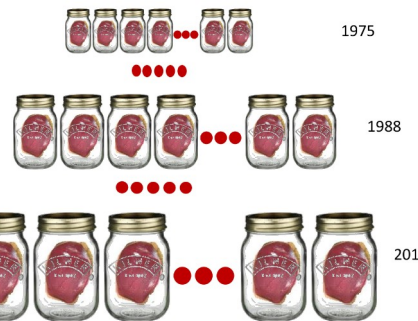
POPs: Pinocchio's Dolphin *Delfinus mendax*

There are many more fascinating populations!

	Ad age	Ju age	Ju?	Sampling
Acme Archipelago	✓	✓	✓	
Bilateral Bay	✓	✓	✓	angle traps
Coast of Confusion	~	✓	✓	
Dismal Delta	~	~	✓	
Equitable Estuary	X	✓	✓	unselective
Fruitless Fjord	X	✓	✓	
Gulf of Grim	X	na	X	unselective
Hopeless Harbour	X	na	X	



Many years, many gizzards...



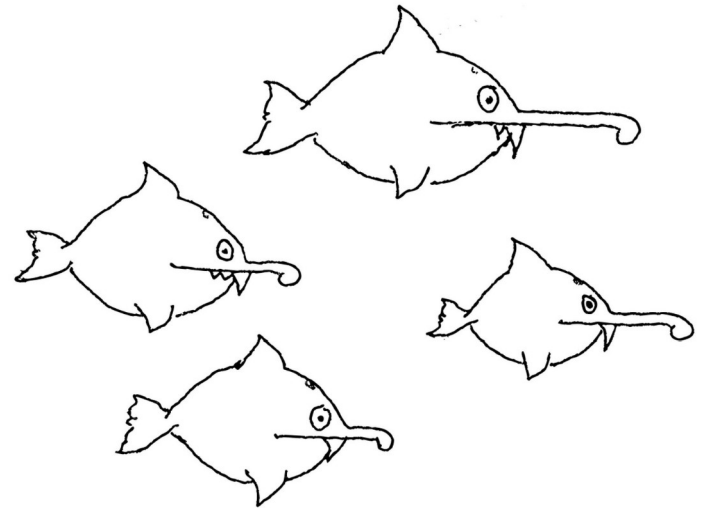
How's the population going?



POPs: Pinocchio's Dolphin *Delfinus mendax*

Dot points... POP-only mammal with *some* age data

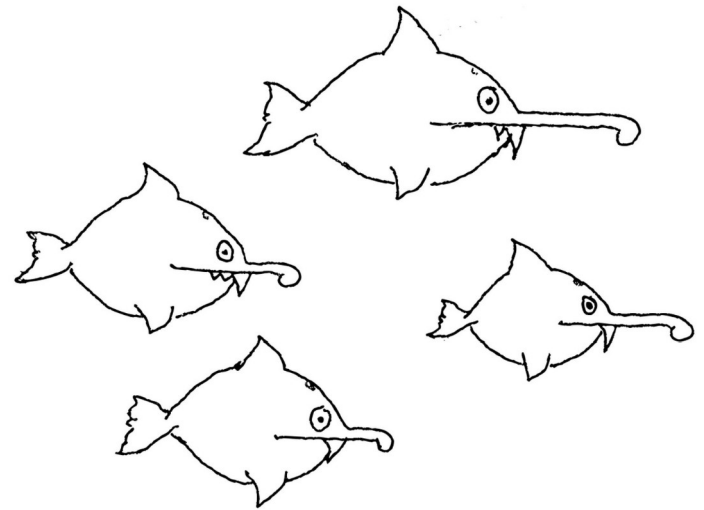
1. Fine for abundance and trend if you use suitable model !
 - Scuzzy age data is PITA but OK up-to-a-point
2. No info on juves
3. No info on adult: mortality, selectivity, age compo



POPs: Pinocchio's Dolphin *Delfinus mendax*

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4. Other things:
 - skip-breed, live-release, males



POPs: Pinocchio's Dolphin *Delfinus mendax*

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3. No info on adult: mortality, selectivity, age compo
4. Other things:
 - skip-breed, live-release, males
5. What **didn't** we use?
 - AA POPs
 - JJ HSPs
 - (JA, AA "HSPs")

