



S-Index Sustainability Indices

Metrics for Evaluating
Collection Sustainability

Five Years Later

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RIVERBANKS ZOO & GARDEN
columbia south carolina

○ sustainable

- of, relating to, or being a method of harvesting or using a resource so that the resource is not depleted or permanently damaged for future use

- "The Tragedy of the Commons"
 - Hardin, SCIENCE, 1968
- a dilemma arising from the situation in which multiple individuals, acting independently and rationally, will ultimately deplete a shared limited resource, even when it is clear that it is not in anyone's long-term interest for this to happen.

Tragedy of the commons

- Who is responsible for sustainable collection management?
 - The association (AZA)
 - The Taxon Advisory Group (TAG)
 - The Species Survival Plan (SSP)
 - Individual Zoos/Aquariums
 - Individual Collection Managers

S-Index Tool Objective

- How do I quantify the sustainability of the collection I manage?
 - As a whole
 - As parts of the whole
- How do I set sustainability goals for my collection?
- How do I express this in a meaningful way to my supervisors/Director?
- How can data be examined across facilities to examine the status of AZA collections?

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The Metrics

Lambda

$$\lambda_T = \frac{N_{t+1}}{N_t}$$

Intrinsic Lambda

$$\lambda_I = \frac{N_t + B - D}{N_t}$$

Extrinsic Lambda

$$\lambda_E = \frac{N_t + I - E}{N_t}$$

Producer/Consumer Index

$$PCI = E - I$$

Community Impact Index

$$PCI + (N_{t+1} - N_t)$$

The Metrics

- **Lambda (λ)** – **proportional change in collection size** due to growth ($\lambda > 1$) or decline ($\lambda < 1$) in a selected group
- **Intrinsic Lambda (int λ)** – proportional change collection in size due to **Births/Hatches and Deaths**
- **Extrinsic Lambda (ext λ)** – proportional change in collection size due to **Acquisitions and Dispositions**

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The Metrics

- **Producer/Consumer Index (PCI) – Number of Dispositions minus number of Acquisitions** indicating the net balance of animals provided to and accepted from other zoos
- **Community Impact Index (CII) - Net change in collection size plus PCI** representing impact on the AZA (or other selected) community collection due to changes in institutional collection

S-Index Data so far

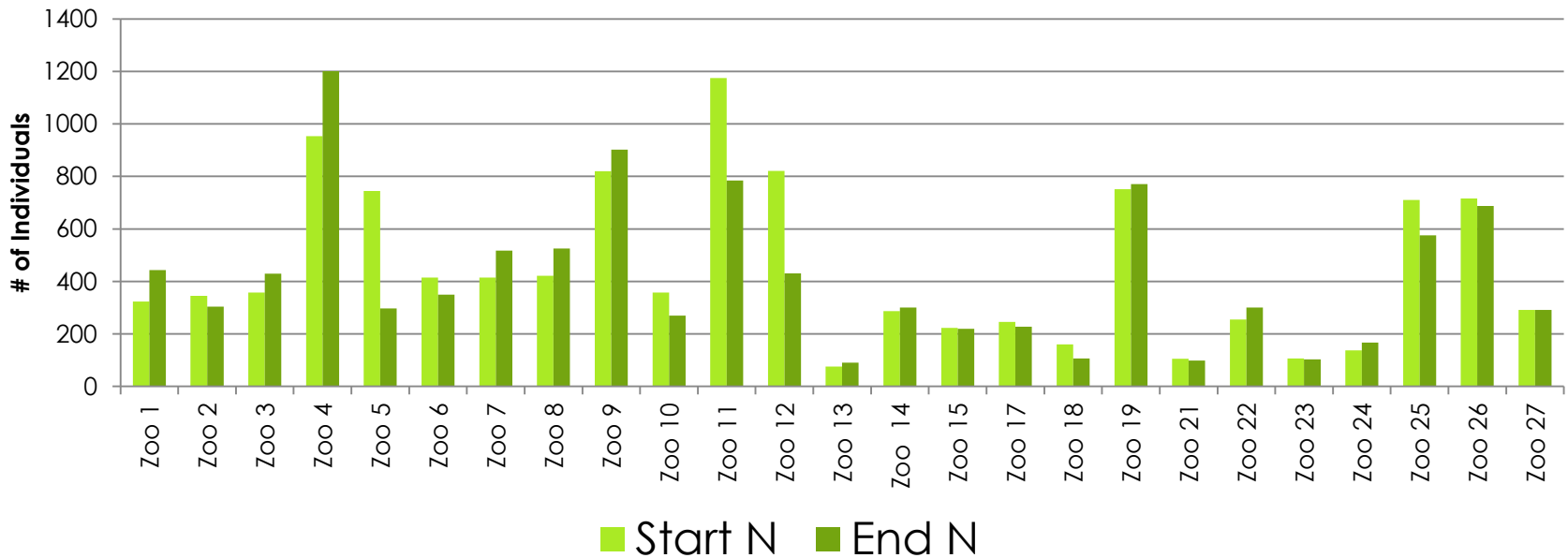
- 25 AZA bird collections 2006-2010 (1st time step)
- 25 AZA bird collections 2011-2015 (2nd time step)
- 23 AZA bird in both data sets
- **Every participating zoo received a detailed report about their own collection**

S-Index Data so far

- Each time step starts/ends with ~10,000 birds
- 1005 reported taxa
- 59,991 reported events (B,De,A,Di)
- **How can data be examined across facilities to examine the status of AZA collections?**

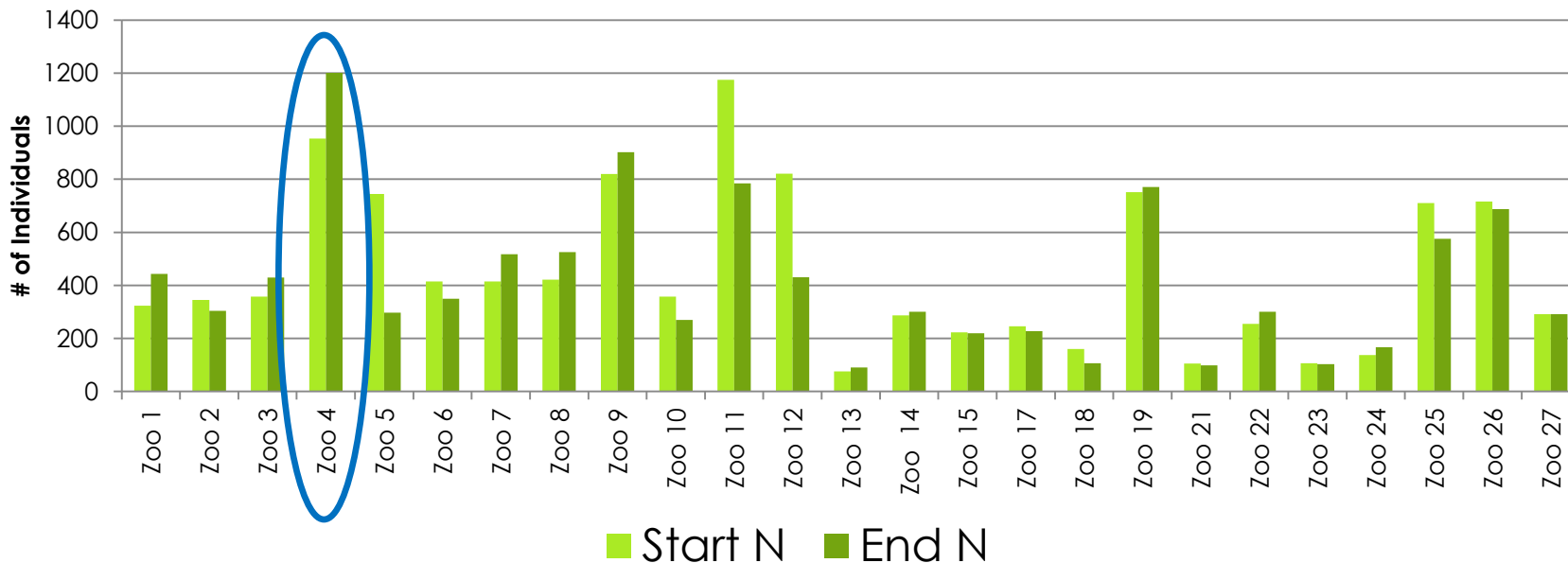
Let's look at individual zoos

Individuals per facility 2011-2015



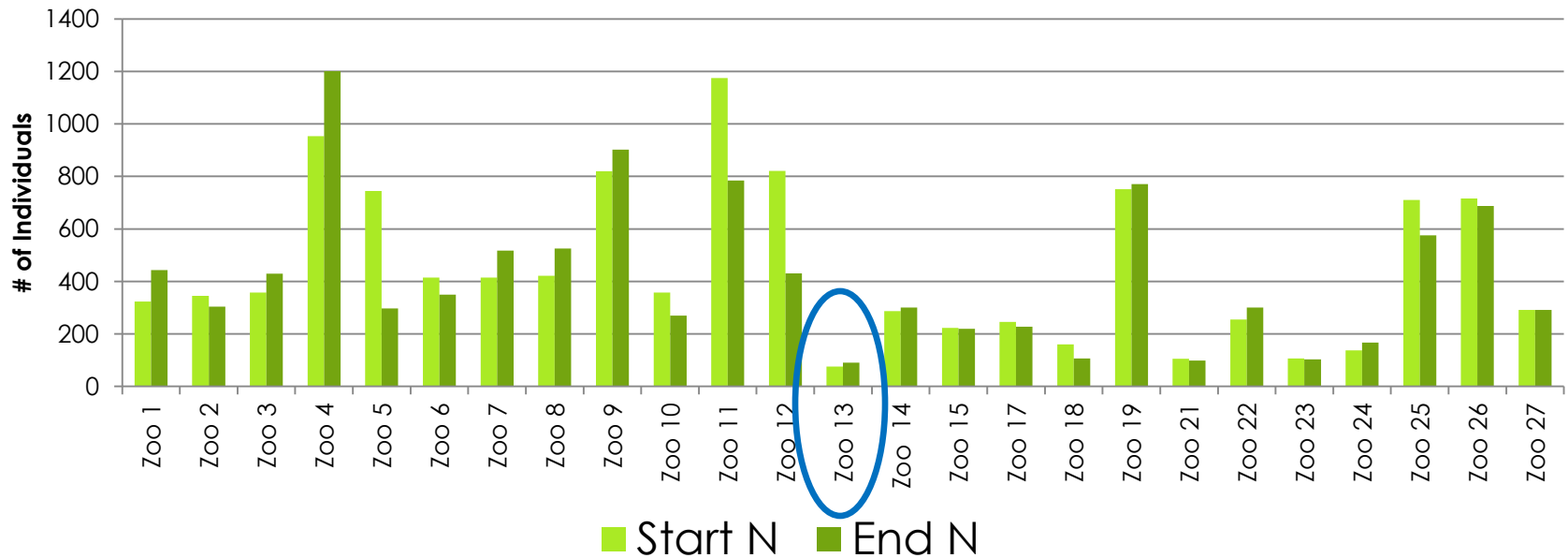
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Individuals per facility 2011-2015

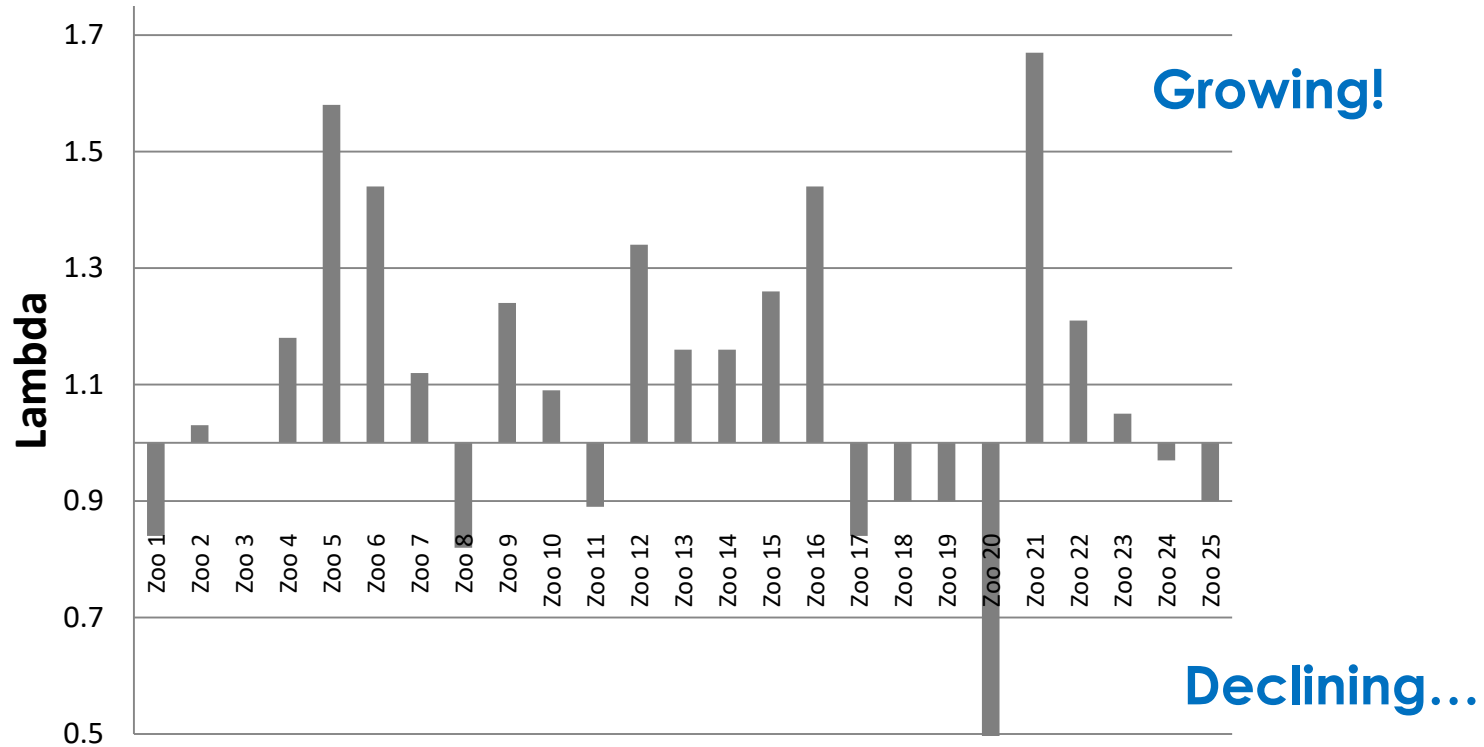


Let's look at individual zoos

Individuals per facility 2011-2015

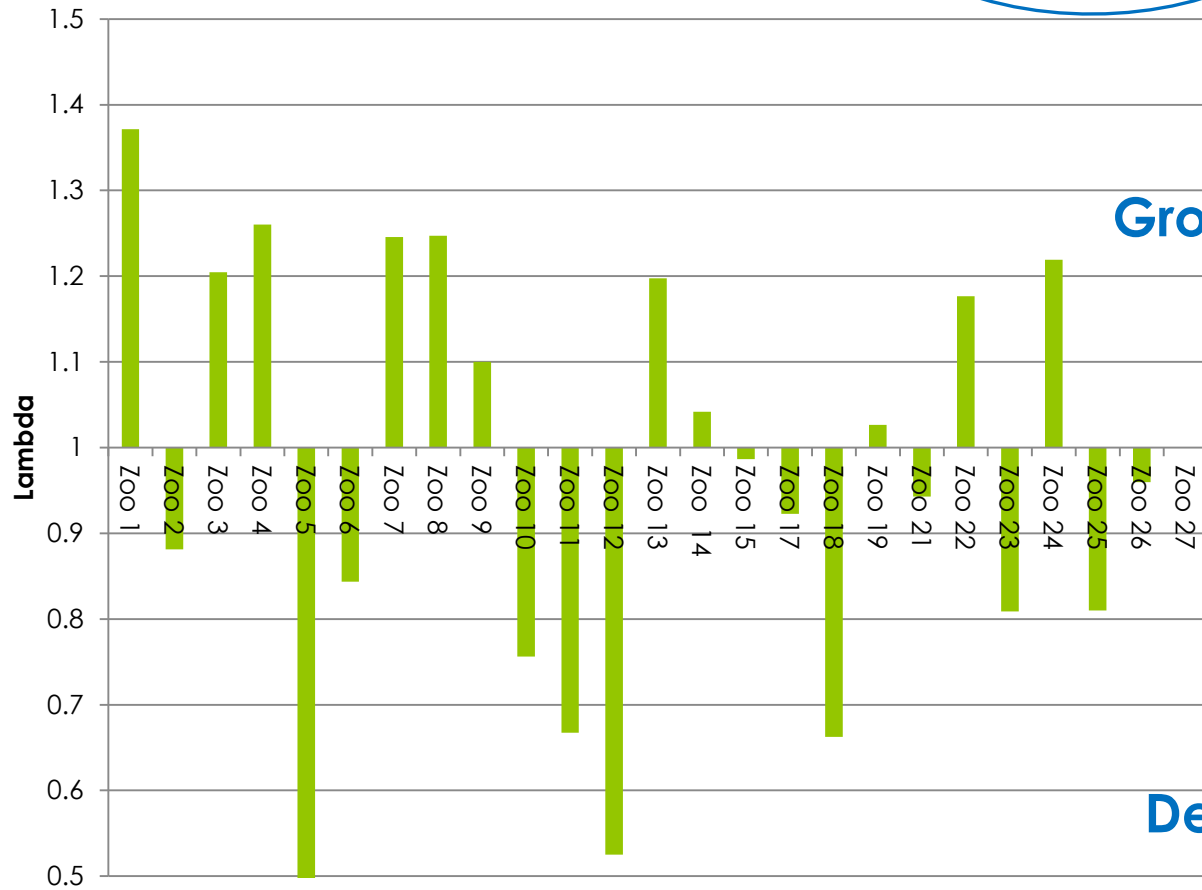


Lambda



Lambda

Hi - I'm Stan

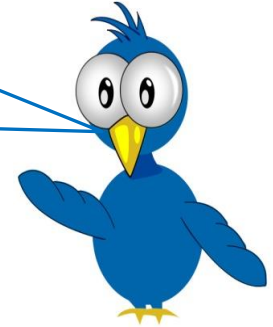


Growing!

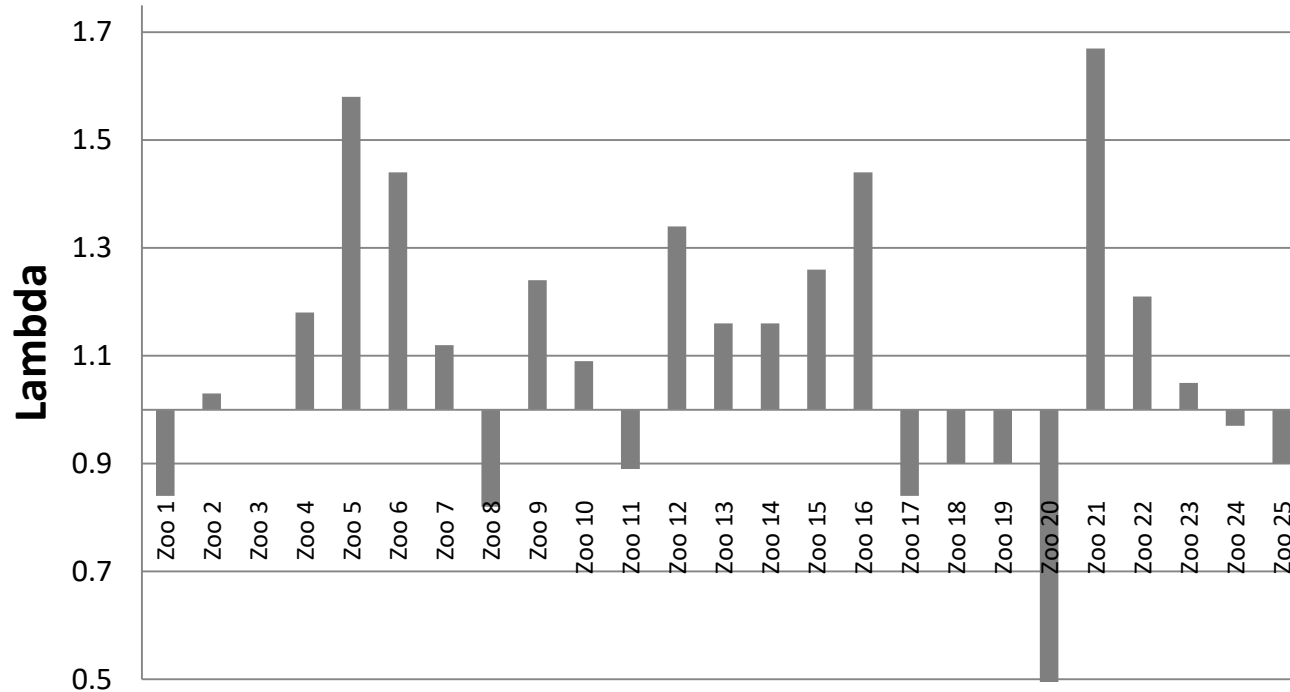
Declining...

Total Lambda

15 of 25 zoos
had growing
collections

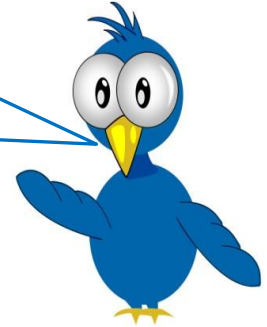


Total λ 2006-10



Total Lambda

11 of 25
collections
are growing.



Total λ 2011-15



Total Lambda

Fewer
collections
are growing.

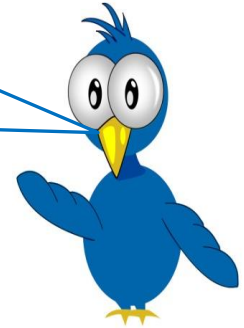


But is the
growth due to
hatches OR
acquisitions?

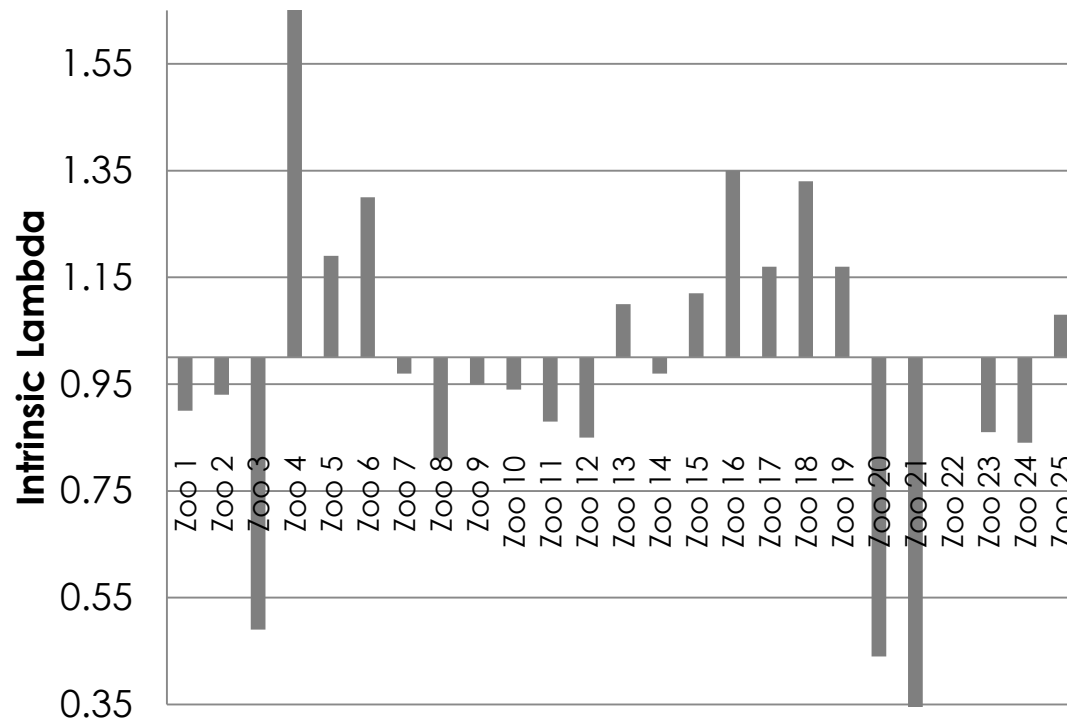
And are the
declines due to
deaths OR
dispositions?

Intrinsic Lambda

10 of 25 zoos
had
births > deaths

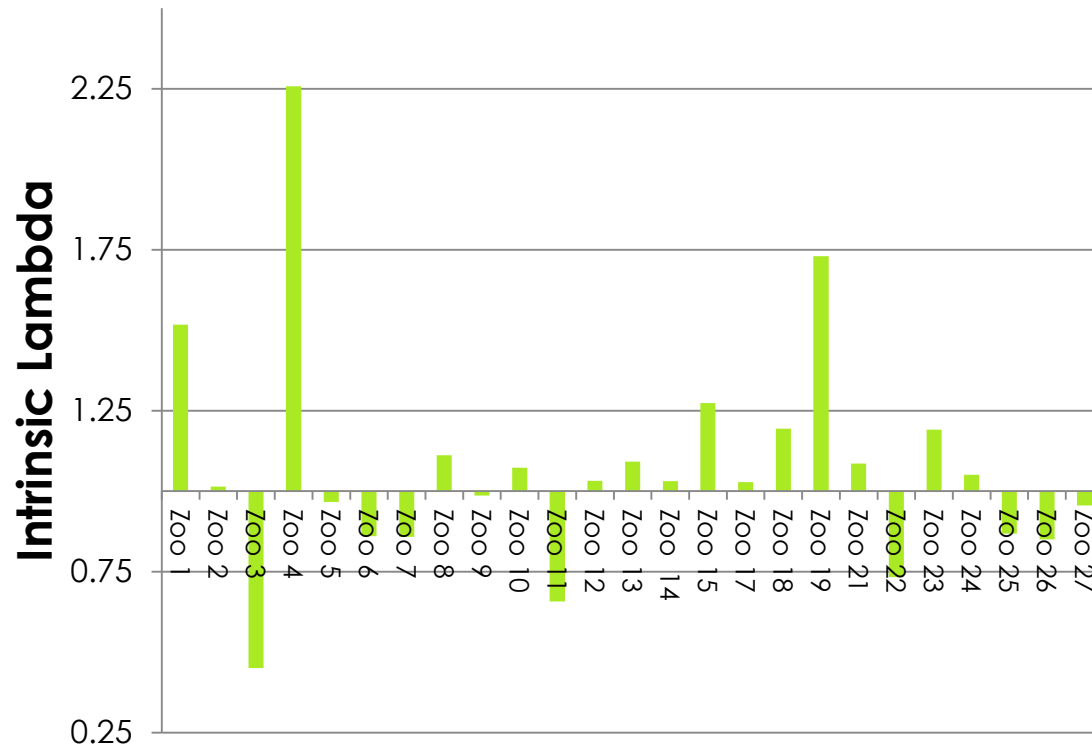


Intrinsic λ 2006-11

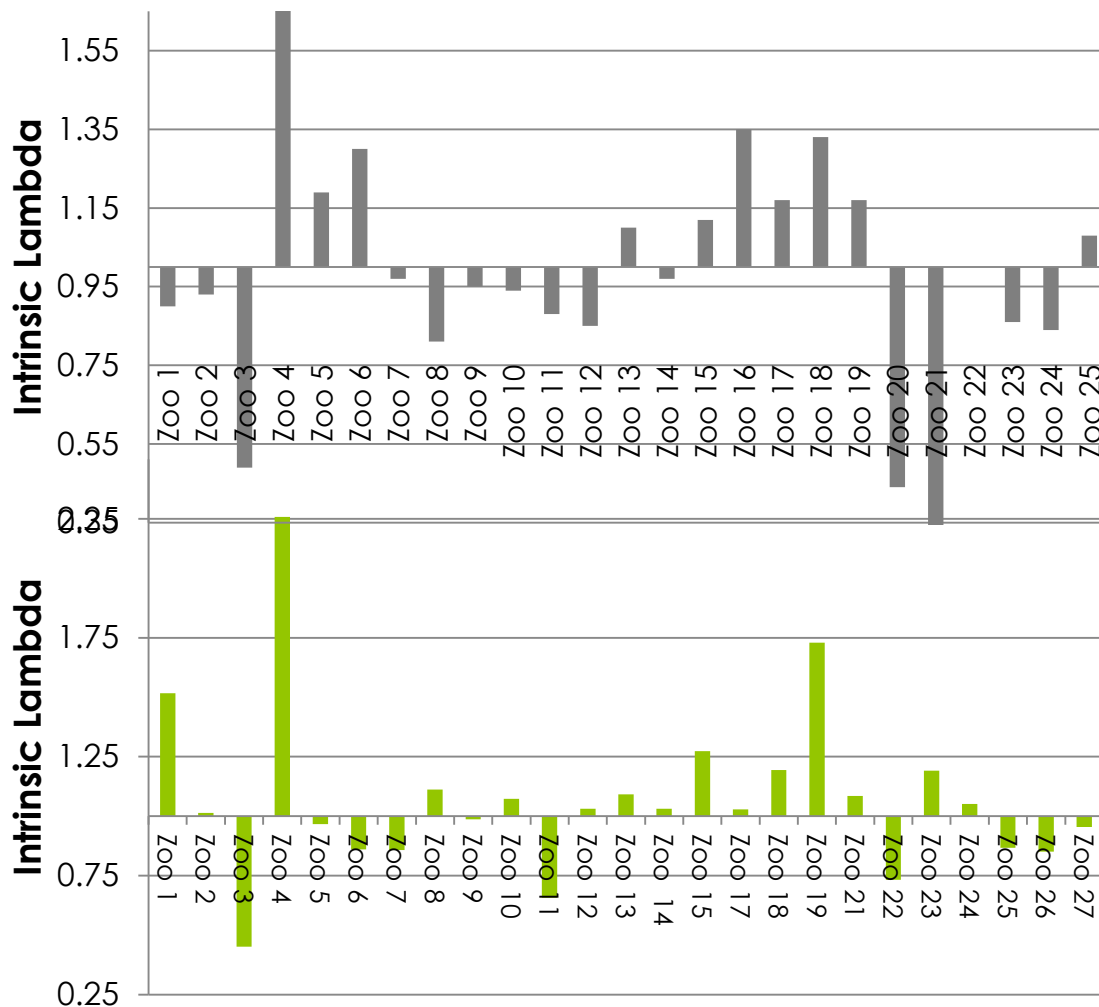


Intrinsic Lambda

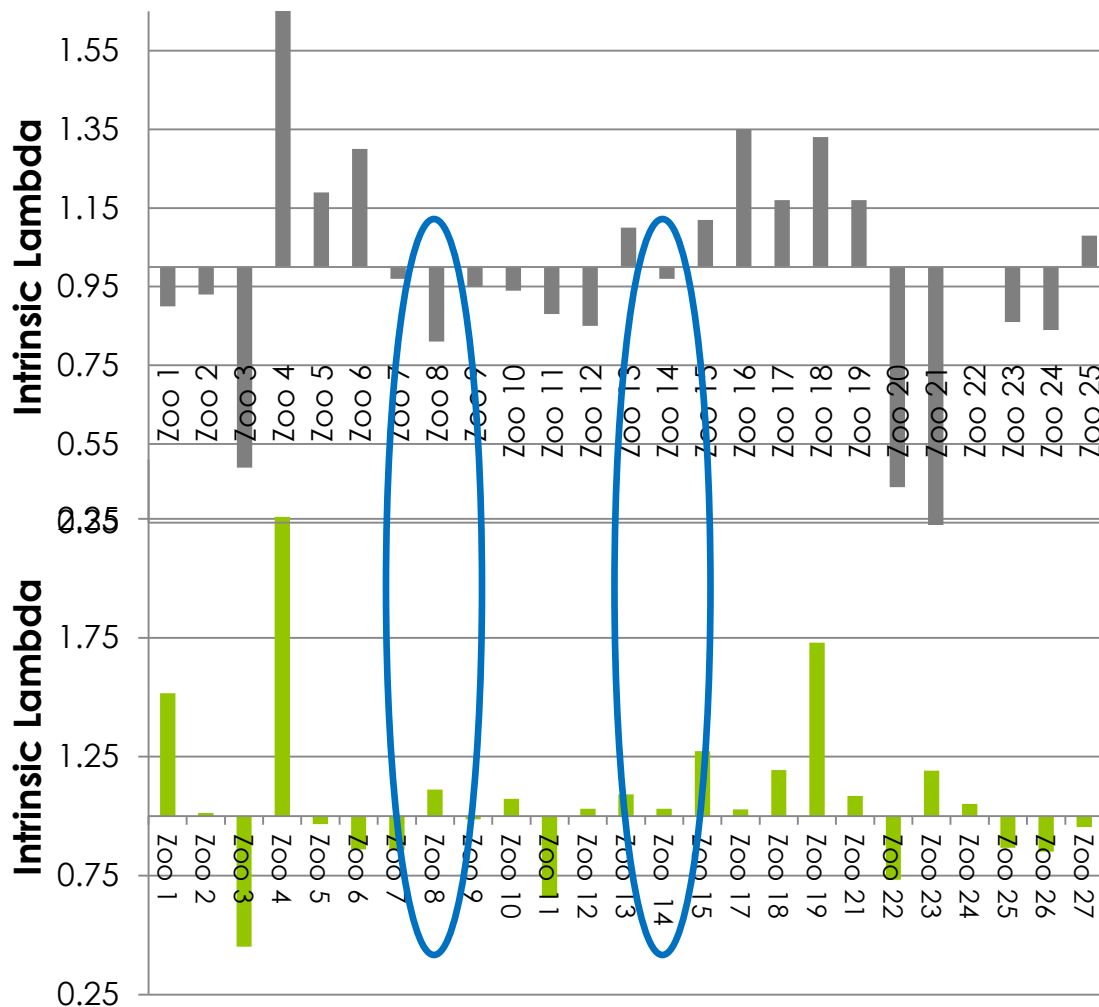
Intrinsic λ 2011-15



Intrinsic Lambda

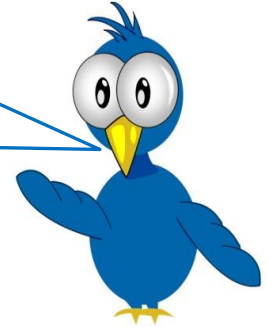


Intrinsic Lambda

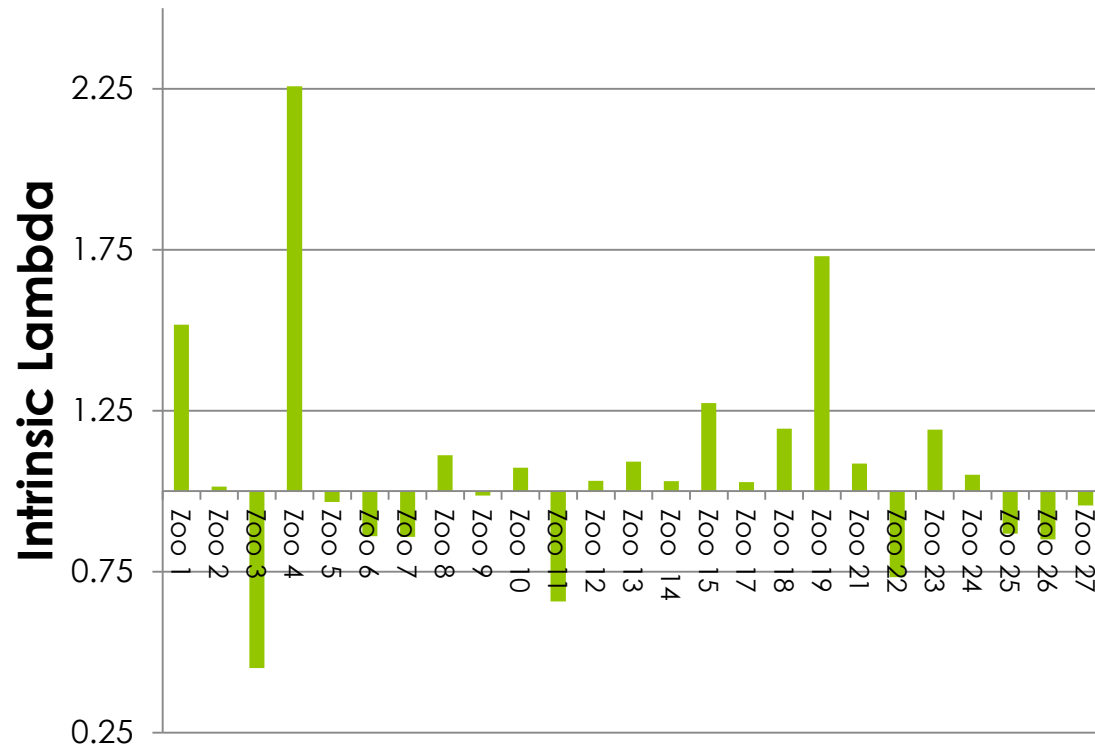


Intrinsic Lambda

14 of 25 zoos
have
births > deaths



Intrinsic λ 2011-15



Intrinsic Lambda

More zoos
have positive
Intrinsic λ
(births >
deaths)



So those zoos that
are not growing
must be having
more dispositions
than acquisitions.

We can
explore this
further using
PCI

Producer/Consumer

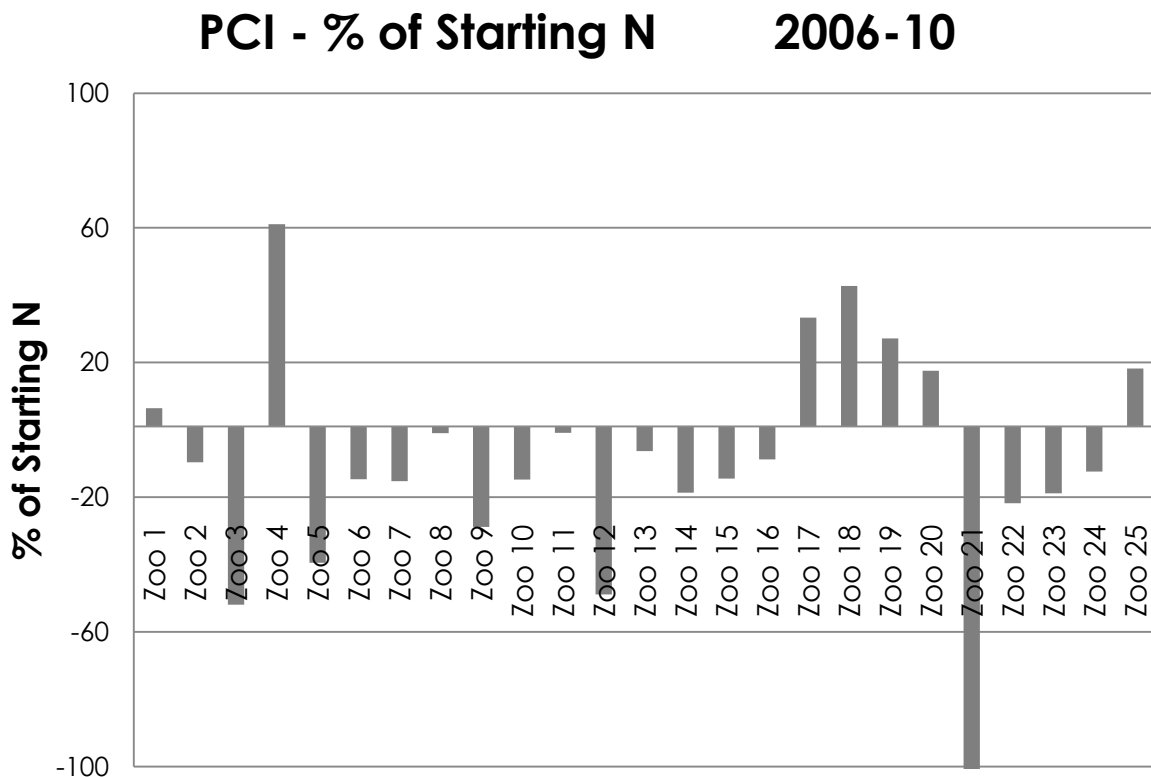
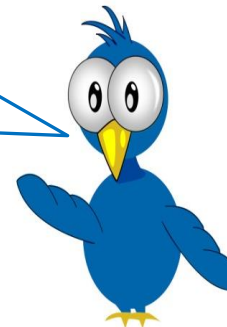
Producer/Consumer Index (PCI) – Number of Dispositions minus number of Acquisitions

indicating the net balance of animals provided to and accepted from other zoos

- **Positive** – I provide more than I take
- **Negative** – I take more than I provide

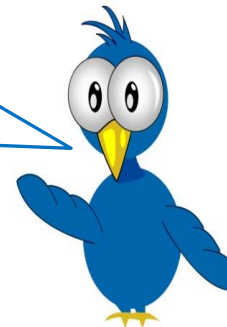
Producer/Consumer

7 zoos had positive PCI

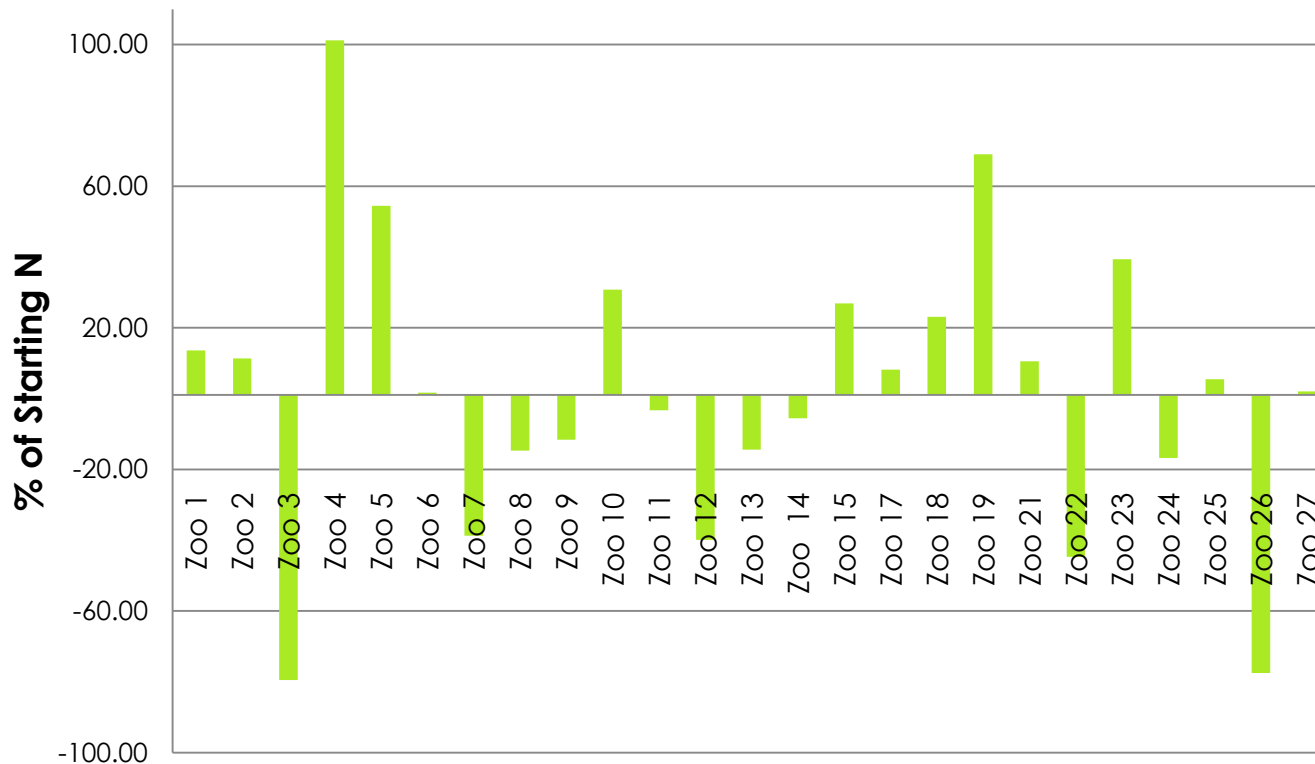


Producer/Consumer

Now it's 13!
That's
almost
double!



PCI - % of Starting N 2011-15



Intrinsic Lambda

More zoos are
Producers



Some of this is
short-term -
Some zoos have
reduced collection
size and shipped
out many animals

But many others
are long-term
producers

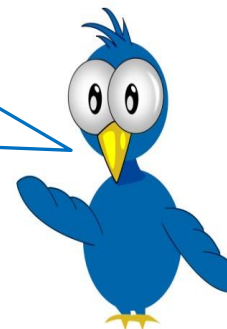
Community Impact

Community Impact Index (CII) - Net change in collection size plus PCI representing impact on the AZA (or other selected) community collection due to changes in institutional collection

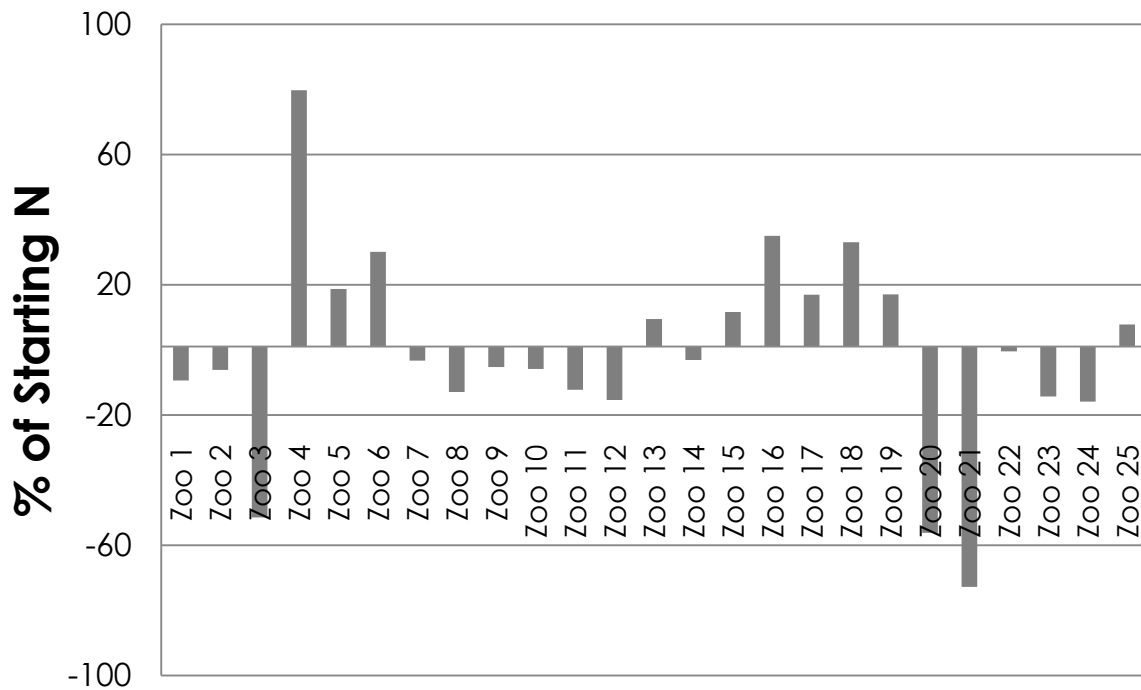
- **Positive** – I've grown my collection and other collections thru my actions
- **Negative** – My collection and other collections have declined thru my actions

Community Impact

10 had positive CII

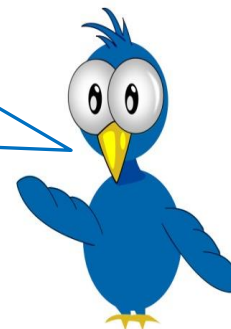


CII - % of Starting Size 2006-10



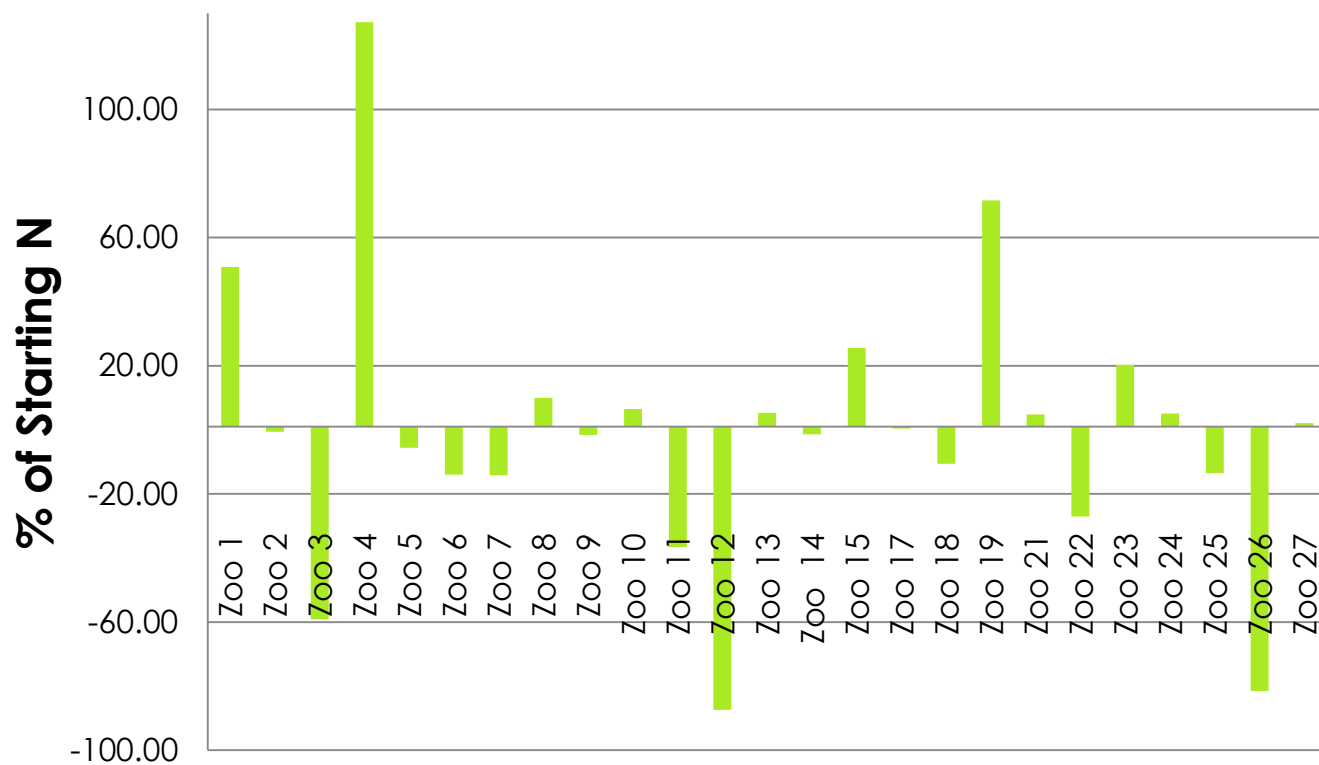
Community Impact

Now it's 11!
A smidge
better...



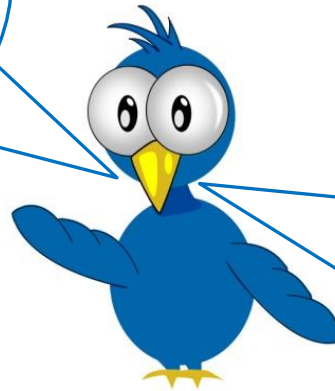
CII - % of Starting N

2011-15



Intrinsic Lambda

More zoos
have positive
Community
Impact

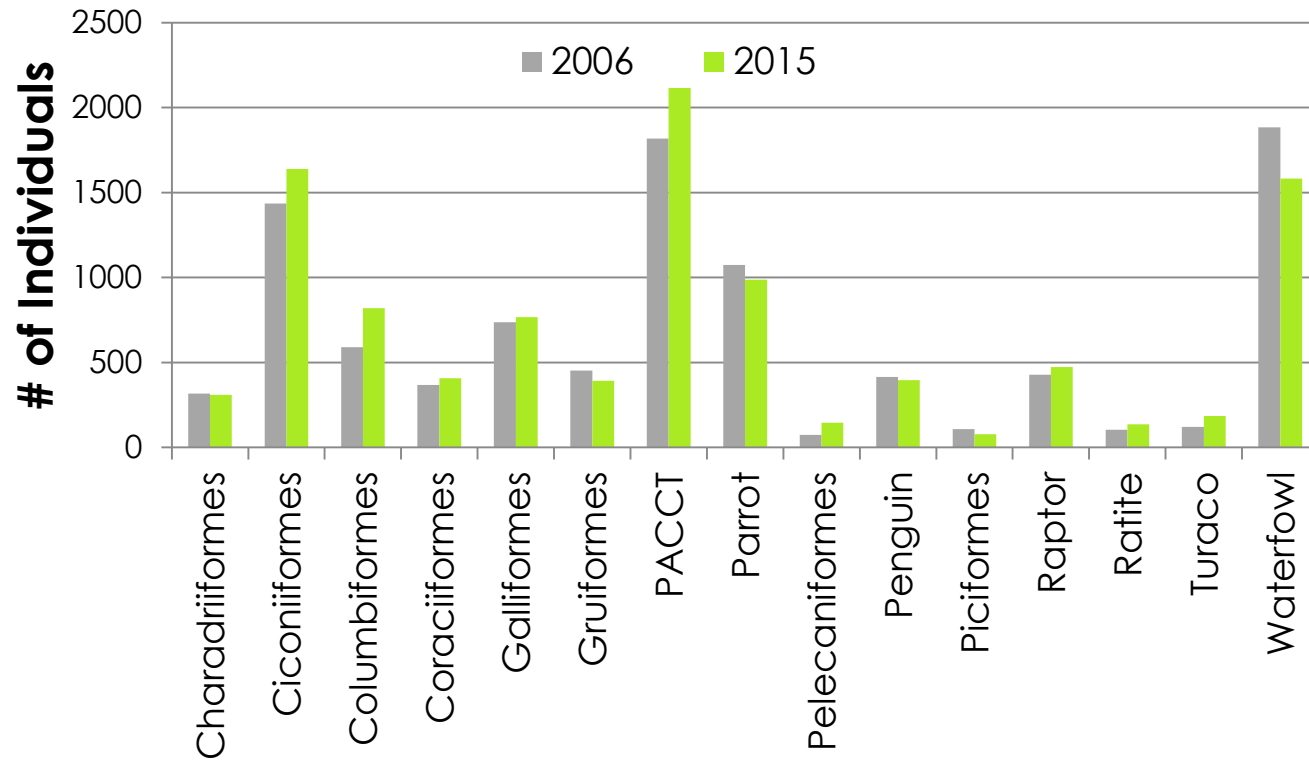


But others are
reducing collection
size by shipping out
without
replacement

Lets's look at the TAGs

- as represented by the study collections

Lets's look at the TAGs



TAGs as represented by 25 study collections

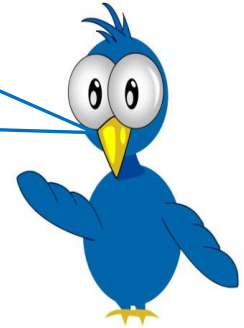
2011-2015	total λ	int λ	ext λ	PCI	CII
Charadriiformes	0.81	0.94	0.92	30	-41
Ciconiiformes	0.97	1.03	1.00	1	-48
Columbiformes	1.20	1.32	1.01	-9	129
Coraciiformes	1.00	1.14	0.94	24	24
Galliformes	1.08	1.54	0.63	264	318
Gruiformes	0.73	1.16	0.73	146	3
PACCT	1.08	1.24	0.93	137	297
Parrot	1.01	0.82	1.29	-284	-271
Pelicaniformes	0.98	0.94	1.20	-30	-33
Penguin	0.98	1.11	0.90	42	35
Piciformes	0.83	1.00	0.97	3	-13
Raptor	0.99	0.88	1.20	-98	-104
Ratite	0.78	1.00	1.01	-2	-39
Turaco and Cuckoo	0.94	1.15	0.96	8	-4
Waterfowl	0.65	1.00	0.87	309	-526

TAGs as represented by 25 study collections

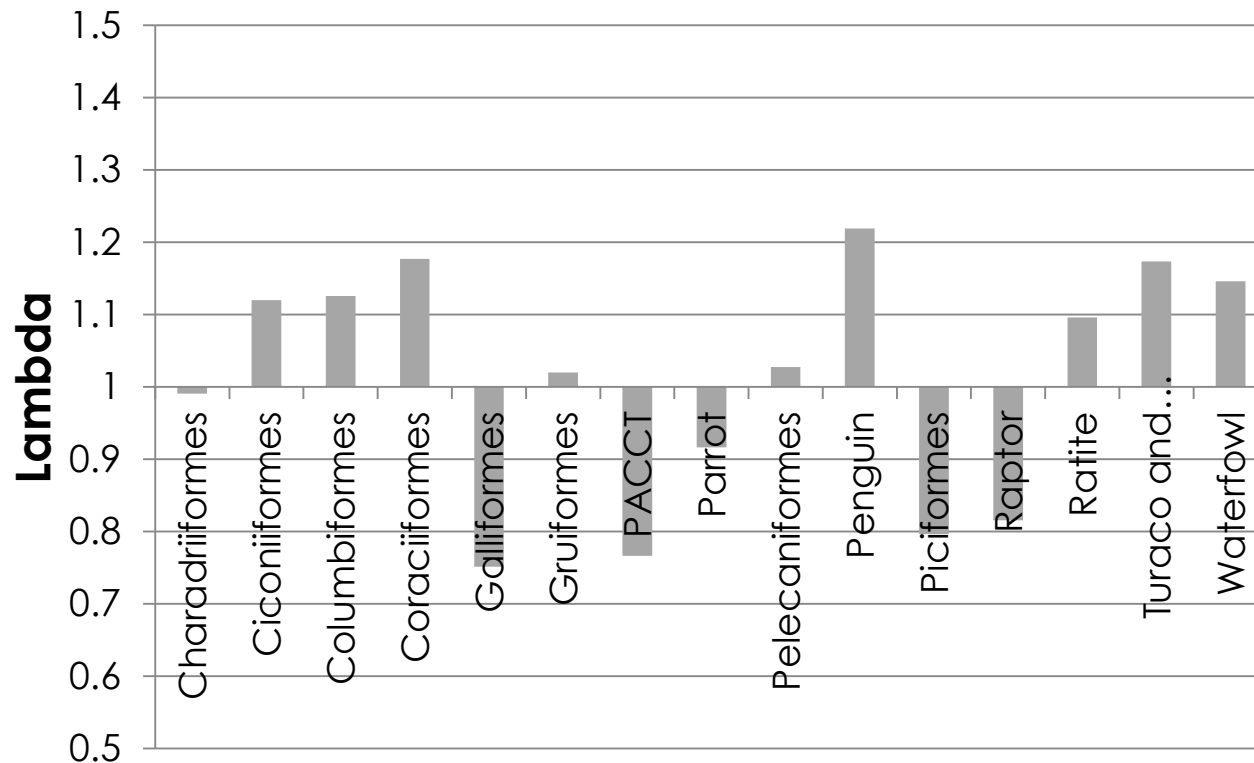
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Intrinsic Lambda

9 of 15 TAGs
have
births > deaths

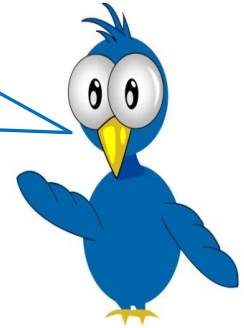


Intrinsic λ by TAG 2006-10

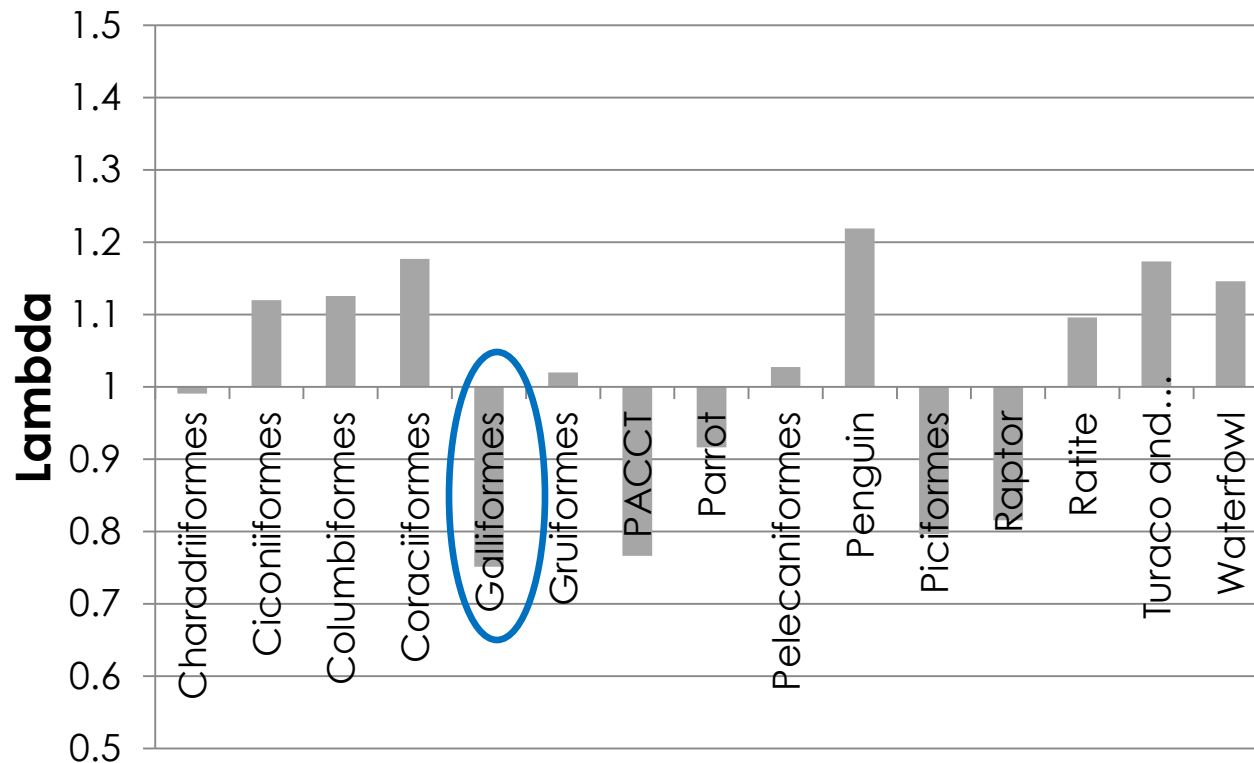


Intrinsic Lambda

And yes
Chris, you
lose...

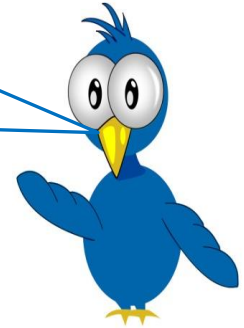


Intrinsic λ by TAG 2006-10

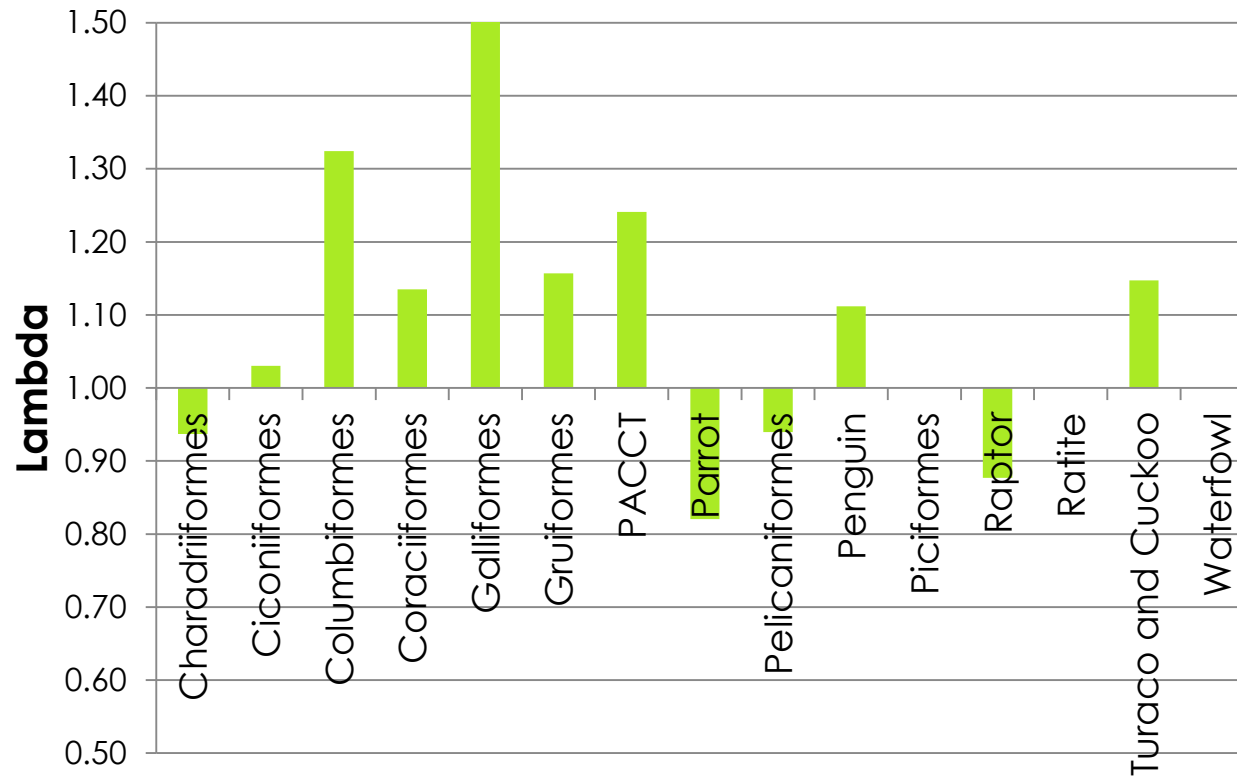


Intrinsic Lambda

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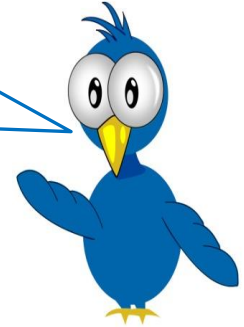


Intrinsic λ by TAG 2011-15

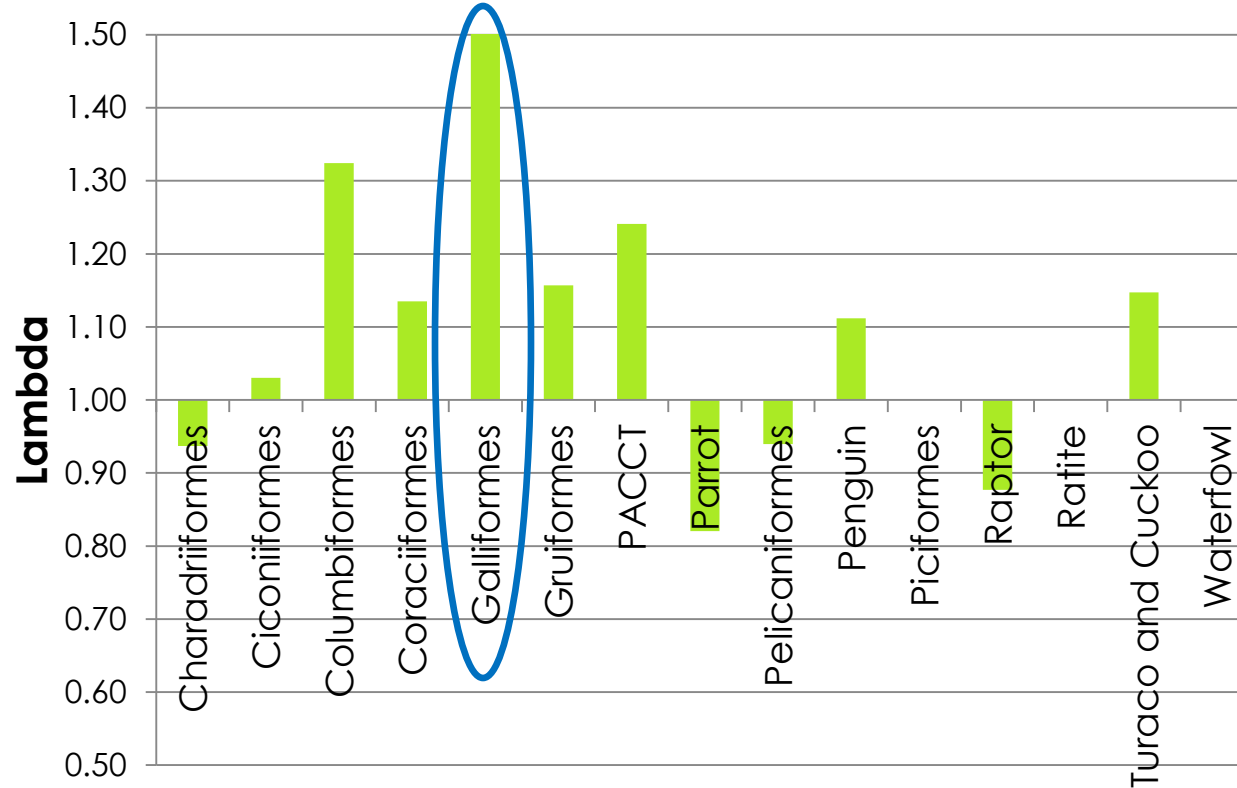


Intrinsic Lambda

And yes
Chris, you
WIN!!!

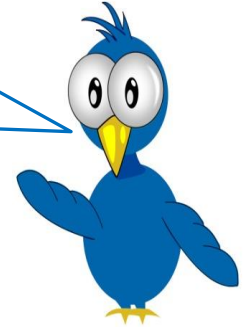


Intrinsic λ by TAG2011-15

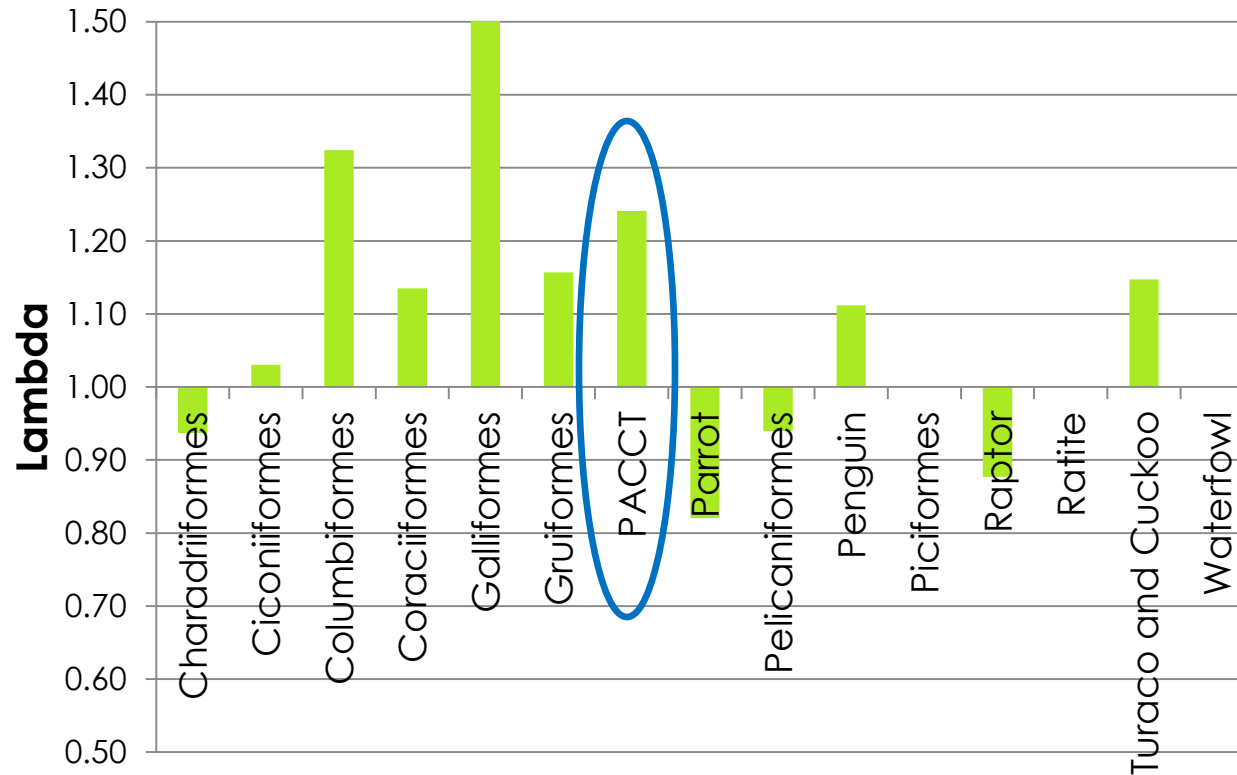


Intrinsic Lambda

Passerines improved too!

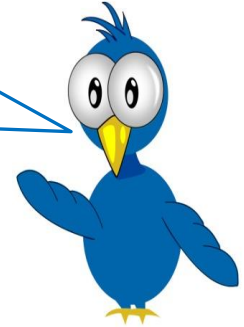


Intrinsic λ by TAG 2011-15

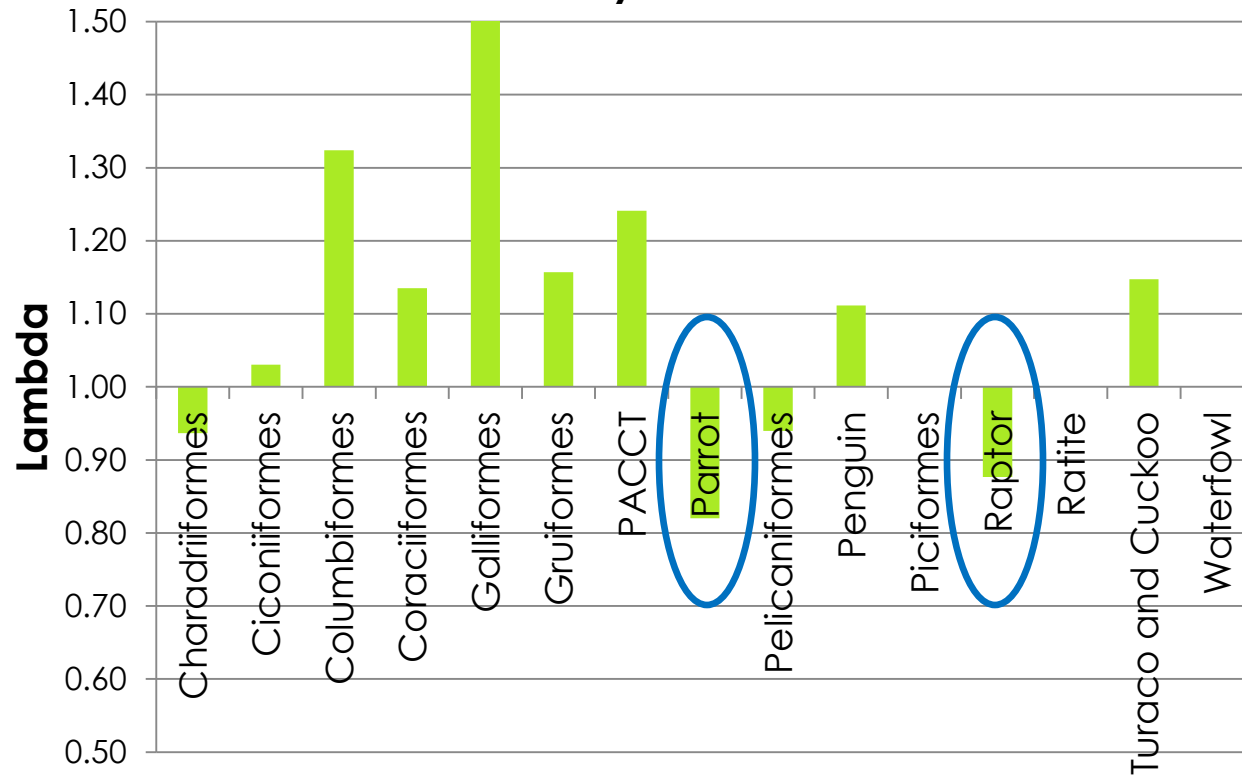


Intrinsic Lambda

And even these may be ok...



Intrinsic λ by TAG2011-15



Intrinsic Lambda

Data varied A LOT between time steps

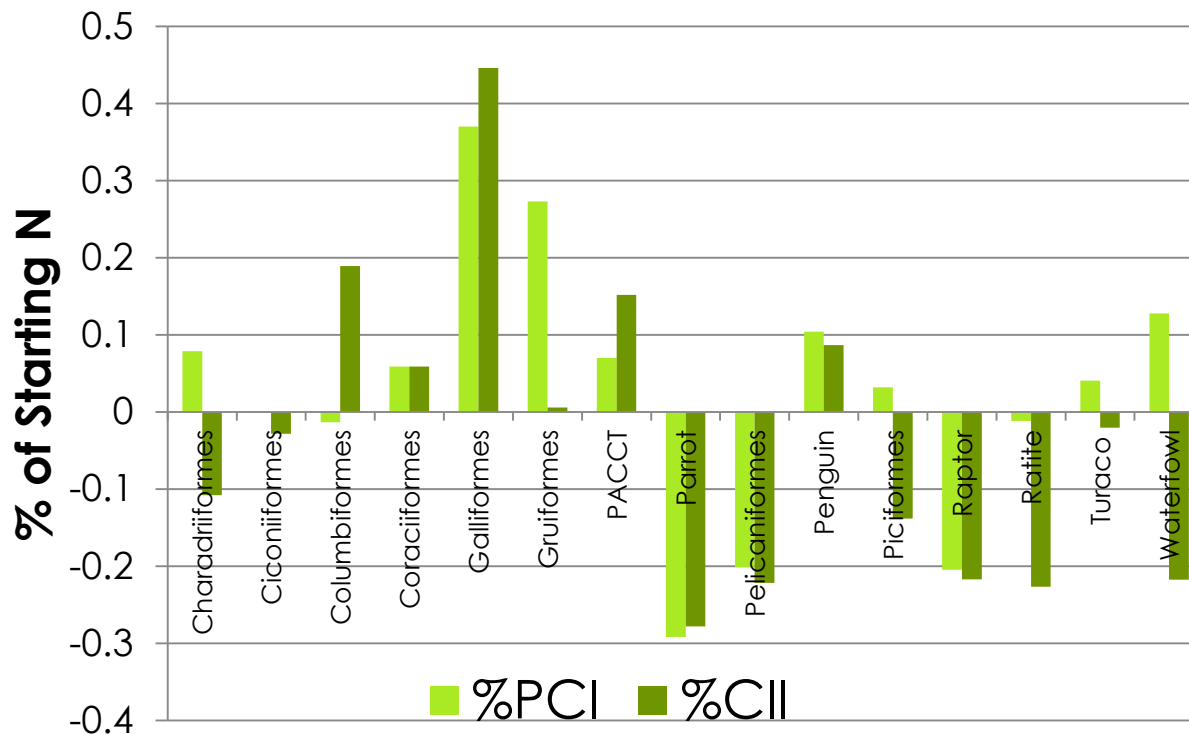


The # of growing TAGs did not change

But the IDENTITIES did!

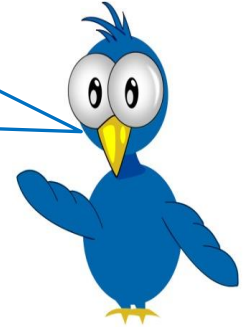
TAG PCI & CII

PCI and CII by TAG (% Starting N)

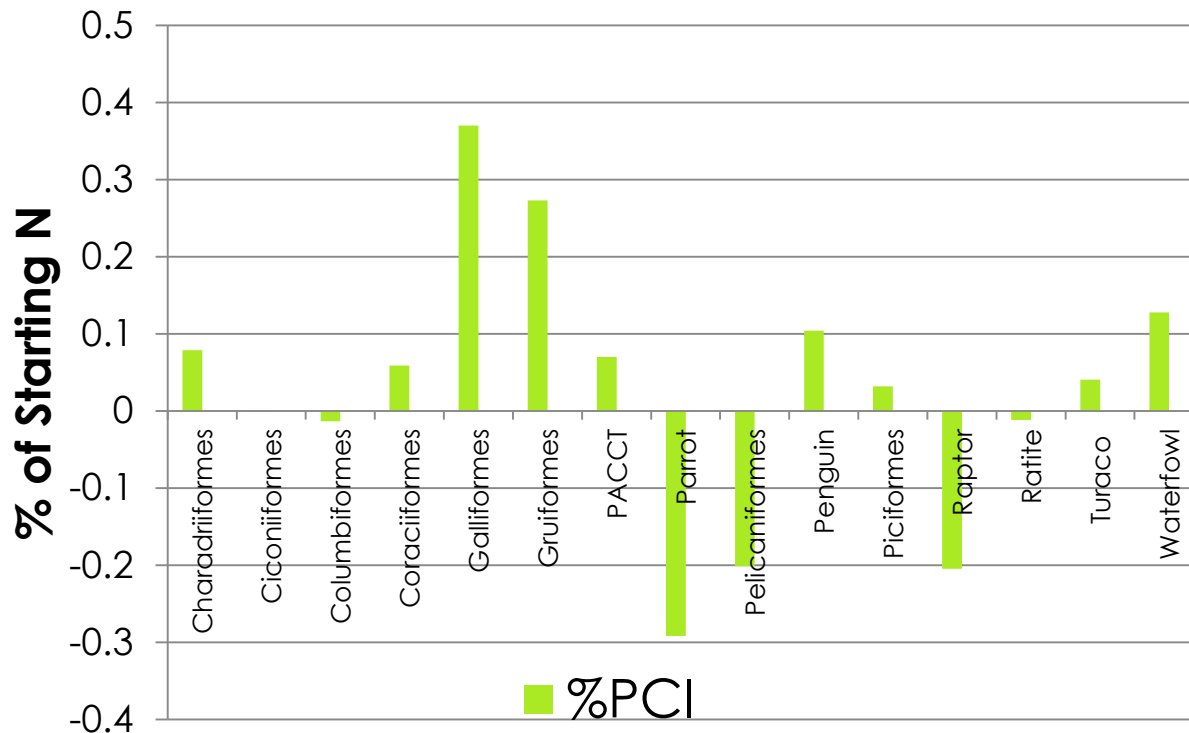


TAG PCI

9 of 15 TAGs
have
positive PCI

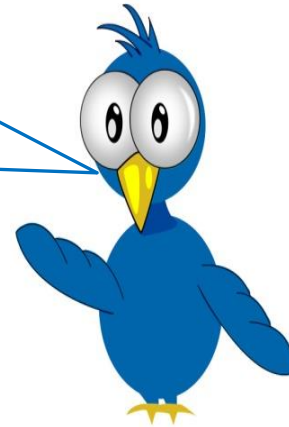


PCI by TAG (% Starting N)



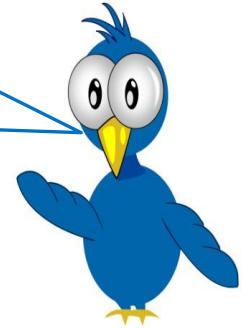
TAG PCI

Increased from
7 in 2010!
Fantastic!

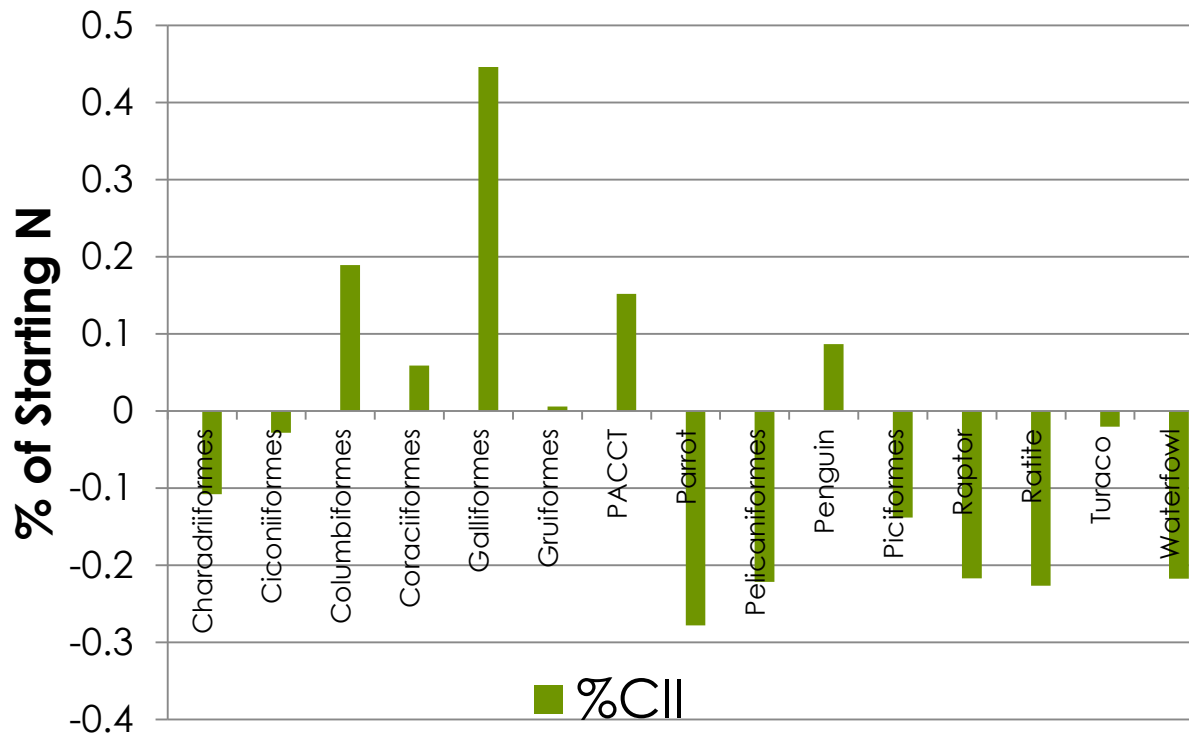


TAG CII

Only 6 of 15
TAGs have
positive CII

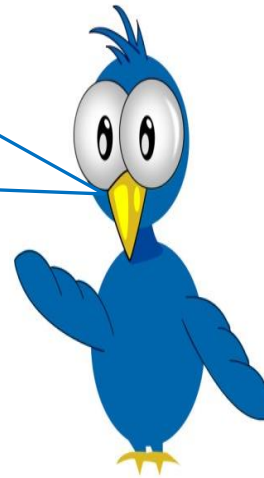


CII by TAG (% Starting N)



TAG CII

Decreased from
9 in 2010...
disappointing



TAG PCI & CII

As with lambda values, there was a lot of variation between the time steps and among the TAGs



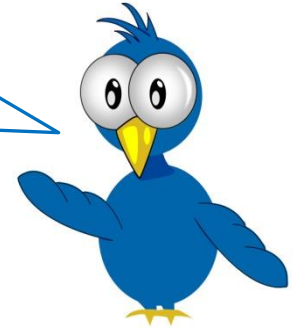
Some TAGS display consistent values while other TAGs flip flopped

But many of TAGs that improved... Improved A LOT

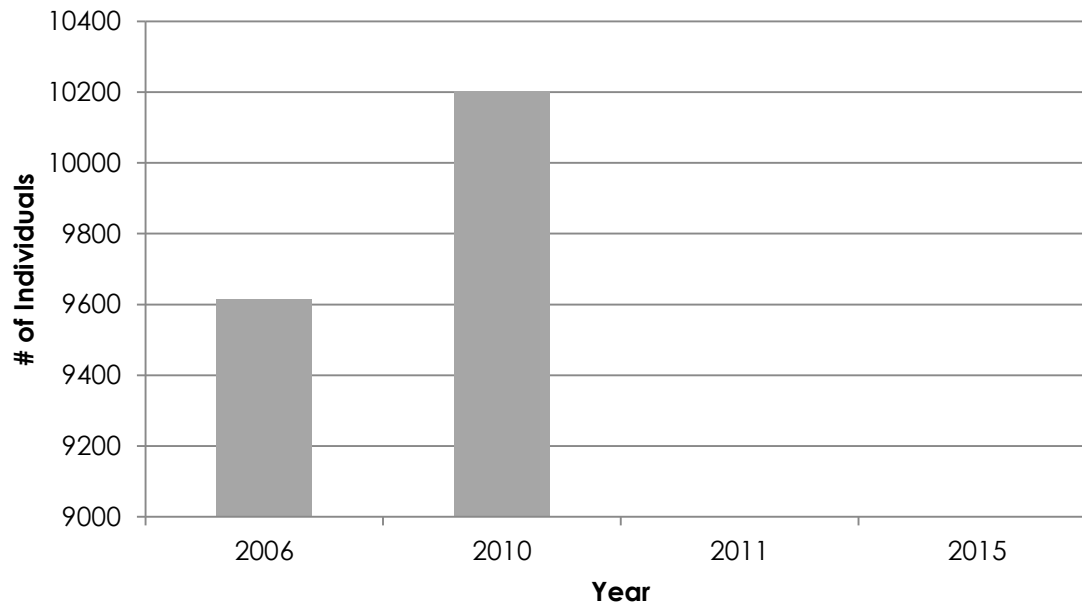
Let's look at AZA

- as represented by the study collections

Looking good!



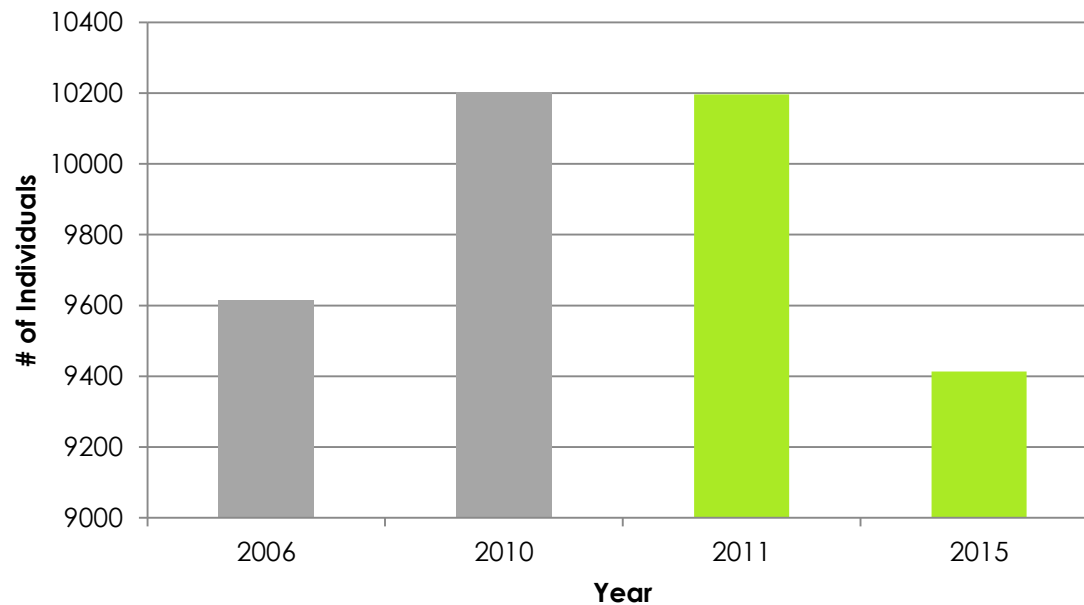
Total # of Birds in 23 Sampled Collections



...not so
great
after all



Total # of Birds in 23 Sampled Collections



In Summary...

- This is a lot to process
- The overall community collection was smaller in 2015 than it was in 2006
- But it seemed, according to some metrics, to be “more sustainable”
 - Was this random chance?
 - Was it a result of managers actually using their S-Index data?

In Summary...

I don't know...

...but I'll do it all again in
2020 and see where we are
then!

In the meantime...

Associations do not make animals,

individual zoos/animal managers do,

**we are all part of the
sustainability solution!!!**

Thank you

Special thanks to the avian managers who shared their data!



RIVERBANKS ZOO & GARDEN
columbia south carolina