

# Who exactly are you? How multiple ploidy levels within the same species can mislead invasion science & management.

Jeffrey Firestone

FirestoneBio@gmail.com

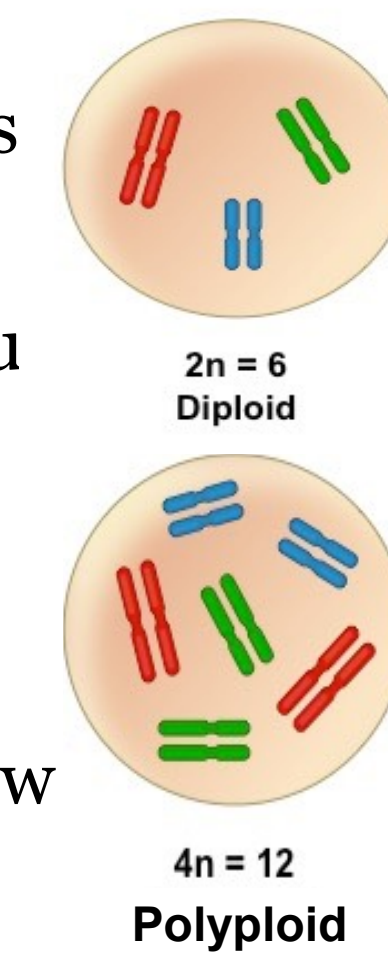
What is ploidy & what does it have to do with invasion?

Unlike what many of us remember from college, the same species can have different numbers of chromosomes (ploidy level).

If we think we know a species, a different ploidy form – a different cytotype – could mislead us

A] Polyploidy is classically associated with different invasion traits – clonal reproduction, apomixis, size, genetic diversity & heterozygosity, drought tolerance, etc. Thus, the “same species” could differ in traits that really matter to us.

B] It's a different entry into the 'lottery' of having the right adaptations & introductions to new territory



## Terminology:

**Ploidy** - number of copies of the genome. Humans are diploid for having 2 copies (one from mom, one from dad). Plants can be diploid or....

**Polyploid** - having more than two copies of the whole genome (>1 from each parent). Many plant taxa are polyploid, but animals almost all diploid.

**Aneuploid** - having 1+ extra chromosome or missing 1 or more. This does **NOT apply to this research** on extra copies of ALL chromosomes instead of variation in individual chromosomes within the genome.

**Cytotype** - Plants within a species that share a particular ploidy level. For example, “In *Butomus umbellatus*, the diploid cytotype can make fertile seeds and bulbils, but plants with the triploid cytotype only reproduce clonally.”

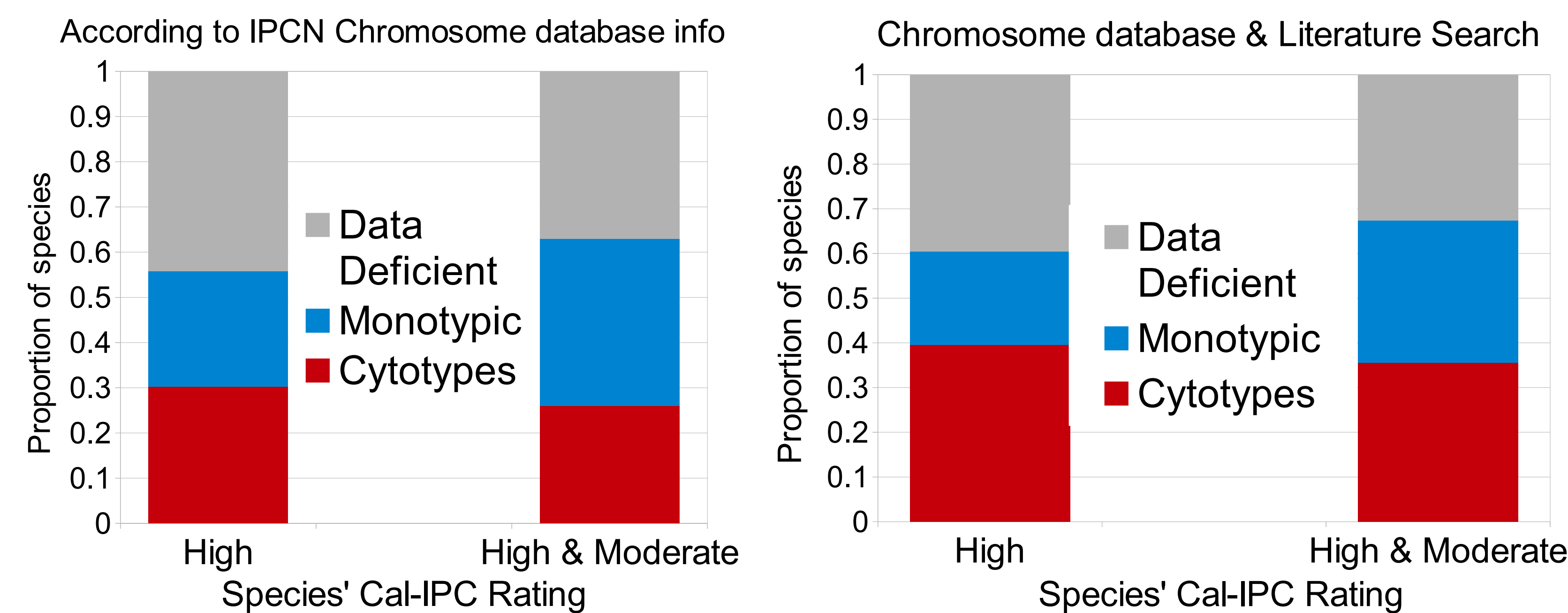
What's the problem?

- Risk assessments are done by species, so they assume the same risk for all cytotypes. Invasion-related traits can be very different between cytotypes.
- Research can be corrupted when genetic tools fail, or ecological comparisons are confounded with chromosomal differences that also occur.
- Biocontrol is not equally effective across all cytotypes.

- Horticulture favors novelty as well as traits that are sometimes associated with polyploidy – clonality, easy propagation, size.... Thus, horticultural interests may actively seek out new cytotypes of known plants, yet they have new risk factors.
- Mostly, if we don't know there are two species hiding as one, what assumptions are we making that are not safe?

How common are cytotypes?

## Cytotypes exist in many Cal-IPC listed species



I searched each of the Cal-IPC High- and Moderate-rated species in the Index to Plant Chromosome Numbers database and a literature search. **Data deficient** means that IPCN had only 0, 1 or 2 counts and, for the right figure, a literature search did not show ploidy level variation. Species level chromosome counts were used for Cal-IPC listed subspecies. Species were searched under synonyms, if known. Frequently, I do not know all synonyms or names prior to a taxonomic split. Thus, some counts will be missed and could increase the number of cytotypes. *Hedera* and *Ludwigia* had 1 species marked with a cytotype and 1 without because of a complicated history of promoting cytotypes to species status. Ask for more details.

Click to see the data table from CAL-IPC lists  
<http://www.tinyurl.com/FirestoneCallIPC-DataTable>

**Cytotypes are much more common in invaders than we realize!**

**At least 150 invasive plant species have multiple ploidy levels.** Usually 1 in invaded range, multiple in native range, but sometimes multiple in invasive range.

**At least 1/3<sup>rd</sup> of Cal-IPC high and moderate list species have cytotypes! That is a widespread commonality considering it is widely unknown.**

**We'll never know how that rate compares to non-invasives, since chromosome counts are not evenly gathered for all species. Still, we need to be careful not to make assumptions out of ignorance of ploidy variation.**

Since multiple ploidy levels are common in invaders, how do I know if my species has them?

### SEARCHING FOR MULTIPLE PLOIDY LEVELS:

- Search Google Scholar for “Genus” “species” “cytotype” and “Genus” “species” “ploidy”
- Search the Chromosome Counts DataBase CCDB that indexes multiple other data sources, including IPCN. Ccdb.tau.ac.il (CCDB has some limitations – ask me for tips – such as multiple copies of the same count)
- **If you have a more serious interest** (e.g. genetics or risk assessment): Search Web of Science / Google Scholar with the species & “polyploid” or “chromosomes”. Repeat Scholar and CCDB searches under other taxonomic names, described below.

### TIPS FOR SUCCESS:

- ✓ Do not search for the phrase “Genus species”. Often a paper might only include “Genus otherspecies” and “G. species” so you would miss it searching for the two words together.
- ✓ Search by previous taxonomic names, and names of sister species that can be difficult to distinguish in the field (including sister species in native range that were promoted from subspecies). Other researchers may have identified them as the same species.

### Recommendations

- **For herbicide use / on the ground management:** No major effect.
- **Risk assessment:** Need literature search, CCDB search. If cytotypes known, flag as additional risk of continued introductions. Some traits frequently associated with higher ploidy levels are also high-risk traits like selfing.
- **White list / black list:** Species with multiple cytotypes must not be white-listed. Specific subsp., var., or ploidy levels acceptable. Different cytotypes are effectively different ecological species as far as risk goes. Meaningful trait variation.
- **Biocontrol:** Applying existing agents – No major effect; Developing agents – not equally effective across cytotypes, although could help narrow down the search range for new agents.
- **Horticultural collection:** Do not assume new variants found in wild have same safety / sterility / risk as existing cultivars. Chromosome count strongly advised if not inter-fertile with existing cultivars. This research not likely to apply to new cultivars from sports.
- **Genetics:** Check literature, CCDB. Different analyses required for ploidy variants. If a population / phenotype consistently fails PCR, has too many alleles, or odd results then count chromosomes.
- **Ecological research or invasive – native range comparisons:** Potential for confounding factors varies by project type – discuss particular project with me.

### Literature Cited:

Detailed attribution at [TinyURL.com/FirestoneCallPCLit](http://TinyURL.com/FirestoneCallPCLit)

**Help me out: What do you think?**

I'm developing this into a journal paper (covering more than just Cal-IPC species).  
 What do you think of the ideas? What concerns do you have? How would it be more relevant to the management community?

**Acknowledgments:** Lindsay Clark & Marie Jasieniuk helped develop these ideas, and my understanding of polyploidy. Sarah Shannon-Firestone and Natasha Sherman both helped move ideas from thoughts to research.