Evaluating differences in sustain between factions - LOTD 12/05/24

Why study this LOTD?

The main reason is because this LOTD (from the 12th of May 2024) **had both sides facing each other with quite similar organization and player gear/RR**. This offers a **unique opportunity to study data in a fairly equalized environment**, having eliminated certain factors that would otherwise skew numbers one way or another.

Here is where all the data that was used in this analysis comes from: **https://killboard.returnofreckoning.com/skirmish/eeaf6f4d58854c52abb76113eee7cb3b**

As I will show later, **all of the calculations**, before the ''Interpretation of the Results'' section, **are fairly simple to reproduce for any skirmish** (*as long as you are willing to invest like 4h transferring data to excel*) and **can give us valuable insight regarding time to kill as well as how well each faction can sustain itself during fights**.

Introduction & Basic Concepts

This topic is decently complex and as such requires some definitions to be able to quantify certain concepts and so that we are all also on the same page.

True Time To Kill, TTTK $\in (0,+\infty)$ [s]

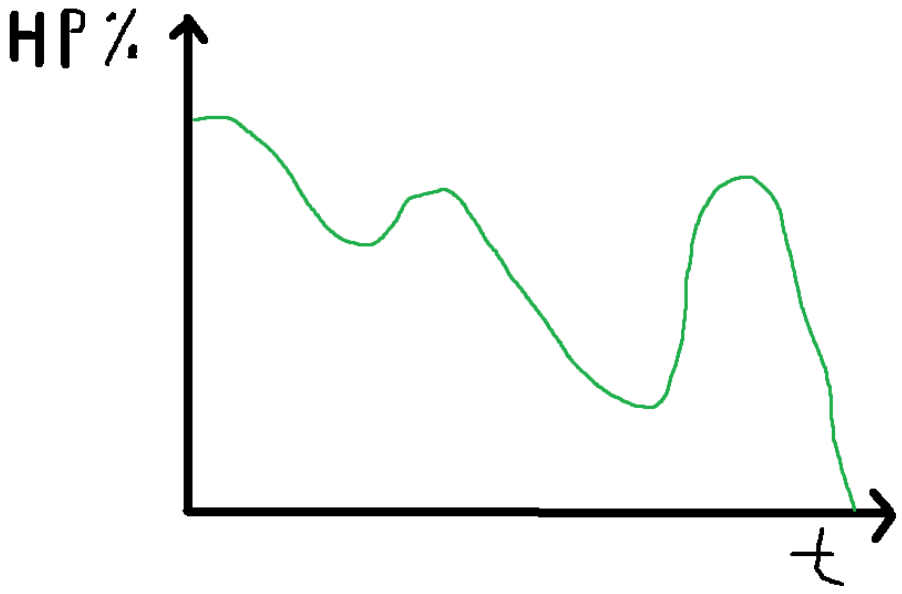
Refers to the time it takes (in seconds) to drop a player's HP from 100% down to 0% without the HP going back up to 100% in between.

Recovery, R ∈ [0,+∞)

It refers to the ability to counteract incoming damage (after mitigations) and leads to slowing down of TTTK.
Since healing is done not in a continuous manner but in discrete intervals, **we will be examining the time-averaged and faction-averaged Recovery** here.

Having 0 recovery means that the enemy damage is never healed and the HP% curve of a character dying would look something like this:

A value of Recovery above 0 and below 1 could result in a kill-curve like this:



Having Recovery equal to or above 1 means that the character would never die.

We can describe Recovery as the **fraction between the time-averaged true rates** (after mitigations) **of heal and damage on the target**:

$$R = \frac{THr}{TDMGr} \qquad (1)$$

Here, **THr** is the **True Rate of Healing [1/s]** = healing rate after heal debuffs and **TDMGr** is the **True Rate of Damage [1/s]** = damage rate after mitigations

As we explained before:

- if R = 0, target is not getting healed at all
- if R = 1 (or above), the target is getting healed for as much damage as it takes (or more) and will therefore not die
- if R = 0.5, the target is getting healed for half the damage he takes (on average) and will therefore die in twice the time compared to what it would take if he had no heals.

To also quantify Recovery in useful terms, this next metric is also proposed.

TTTKsr ∈ [1,+∞) , True Time To Kill slowdown factor:

$$TTTKsf = \frac{1}{1-R} \text{ , } R \in [0,1) \qquad (2)$$

Having a TTTKsf of 2 (for R = 0.5) means that it would take twice as long to kill a character compared to the base TTTKsf of 1 (for R = 0). Provided the same actual rate of dps is applied to them of course.
An R value of 0 means that TTTKsf = 1 and that TTTK stays as it is and for $R \rightarrow 1$, the limit of TTTKsf approaches infinity (kill will never happen).

Let's get a bit more into that.

True Time To Kill, TTTK can also be quantified as such:

$$TTTK = \frac{HP * TTTKsf}{DMGr * (1 - mitigation_{individual}) * (1 - mitigation_{group})} \quad (3)$$

Let's break it down:

- **HP** is the **total HP pool** of the character that died.
  For example 8830 HP = 883 Wounds

- **DMGr** is the **Damage Rate [1/s]** applied to the character **before mitigations**. For example 5320 damage/second

- **Individual mitigation ∈ [0,1)** describes the **time averaged damage reduction** from the targets **own stats** (armor, resists, Toughness, parry%, block%, dodge%, disrupt%)

- **Group mitigation ∈ [0,1)** describes the **time averaged damage reduction** of the target attributed to **outside sources** (Guard, Challenges to enemies hitting them, Laurels of Victory, Oppression, etc.)

For example, for R = 0.5 , HP = 8830, DMGr = 5320/s, individual mitigations = 0.5 (50%) and group mitigations = 0.5 (50%) we'd have

$$TTTK = \frac{8830 * (\frac{1}{1-0.5})}{5320 * (1-0.5) * (1-0.5)} = \frac{17660}{1330} = 13.28\ seconds$$

But we can transform eq.(3) further:

$$TTTK = \frac{HP * TTTKsf}{DMGr * (1 - mitigation_{individual}) * (1 - mitigation_{group})} \Rightarrow$$

$$TTTK * DMGr * (1 - mitigation_{individual}) * (1 - mitigation_{group}) = HP * TTTKsf$$

Notice now that the **left part of** the transformed **equation** represents the **total kill damage** on the target; the **time it took to kill them times the true rate of damage, TDMGr** (= unfiltered * all mitigations)

Therefore the right part of the equation which is their effective HP pool, **HP * TTTKsf, should also be equal to the kill damage.** This makes sense because you can only damage them for as much effective total HP they had during the kill process as defined in the introduction.

This is **the base of the analysis** I will be performing below, with direct results for the **time-averaged and faction-averaged True Time To Kill slowdown factor** as well as for the **time-averaged and faction-averaged Recovery for both factions.**

Let's begin!

Basic Assumptions

Although **they are not needed in the initial calculations themselves**, these basic assumptions are **useful** if we are to **compare results between similar realm forces**. As mentioned in the preface, these assumptions hold true for this LOTD.

Similar Degree of Organization

A similar degree of organization between two sides is a prerequisite for this discussion. If pugs are fighting vs premades, then the data is nearly worthless.

In this case the guilds that had at least 6 people participating were:

- **Retribution**
- **Gimle**
- **Cross**
- **LNM**
- **Casual Suspects**
- **Les Dragons de Kalidors**
- **Pax Mortis II**

vs

- **FMJ**
- **Bene Gesserit**
- **Hand of Blood**
- **Black Horror**
- **Entropy and Chaos**
- **Clan Kass Kranes**
- **Da Freebootaz**
- **Big Inc**
- **Dante's Inferno**

Although it's not exactly equal, this lineup indicates that at least on the level of organization, this LOTD was quite balanced. Moving on to the next assumption.

Minimal Gear Differences

So as to quantify this in an easy manner, I make the **assumption** that **certain renown brackets** contain **players of similar gear** across both factions. Therefore, this problem is translated to the **number of people between factions that are in similar renown brackets**.

The brackets I choose is:

1. 57 or under for PvE gear
2. 58 - 67 for Vanq gear
3. 68 - 77 for Trium mix
4. 78+ for Endgame setups

After tallying up each character that participated, the results are:

Career	57 or under	58-67	68-77	78+
Destro Tank	9	6	9	24
Order Tank	4	7	9	22
Destro Dps	8	16	14	42
Order Dps	9	12	22	47
Destro Heal	18	13	14	34
Order Heal	3	13	15	24

In total 48 tanks, 80 dps and 79 healers for Destro and
In total 42 tanks, 90 dps and 55 healers for Order

Upon further request I'm also adding the **class breakdowns**:

Tanks	57 or under	58-67	68-77	78+	**Total**
Chosen	**3**	**4**	**1**	**12**	**20**
Black Orc	**4**	**2**	**2**	**5**	**13**
Blackguard	**2**		**6**	**7**	**15**
Kotbs	**1**	**4**	**3**	**12**	**20**
Swordmaster	**1**	**2**	**3**	**8**	**14**
Ironbreaker	**2**	**1**	**3**	**2**	**8**

DPS	57 or under	58-67	68-77	78+	**Total**
Choppa		**6**	**4**	**14**	**24**
Mara	**4**	**3**	**1**	**2**	**10**
SH	**1**	**1**	**2**	**8**	**12**
Sorc	**3**	**3**	**5**	**11**	**22**
Magus		**3**	**2**	**2**	**7**
Witch Elf				**5**	**5**
Slayer	**1**		**1**	**4**	**6**
White Lion	**2**	**2**	**6**	**16**	**26**
Bright Wizard		**1**	**4**	**17**	**22**
SW	**2**	**4**	**4**	**3**	**13**
Engi	**3**	**4**	**5**	**3**	**15**
Witch Hunter	**1**	**1**	**2**	**4**	**8**

Career	57 or under	58-67	68-77	78+	Total
Zealot	6	6	4	18	34
Shaman	7	5	5	4	21
DOK	5	2	5	12	24
Runepriest	3	6	6	5	20
Archmage		3	3	11	17
WP		4	6	8	18

If you add those numbers up you will notice that they don't correspond exactly to the total number of players killboard says participated:

This happens, from my understanding of it, because the game displays the names/stats of some players twice when filtering by deaths for example. Not sure why the double entries were there (most likely a bug) but I did my best to not repeat any names when tallying up the numbers and that resulted in approximately 20 less people from each side.

Considering how Destro players left and probably got **replaced by less geared players** that had fewer tickets, I'd say overall the **numbers in each bracket for both factions** are looking **quite comparable**.

Perfect Class Distribution

This assumption states that **no party in either faction** ''wasted'' class-buffs by **having more than 1 of that class**.
For example: This assumption states that there weren't any 2 Zealots in one party or any 2 Bright Wizards.
This might not be completely true, but due to the high degree of organization on both sides **it should hold mostly true**.

Calculations and Results

Initial Calculations

After showing that both realms had similar degree of organization and minimal gear differences, we are now ready to calculate their **faction-averaged & time-averaged Recovery.** As mentioned in the Introduction section, for this we will need the total amount of kill damage each faction outputted.

To gather that, I basically **summed up the individual kill damage of each player for each faction**. Then I **divided that number with the total number of kills that faction achieved** to get the
average kill damage that each faction outputted.

Here's how it looks like:

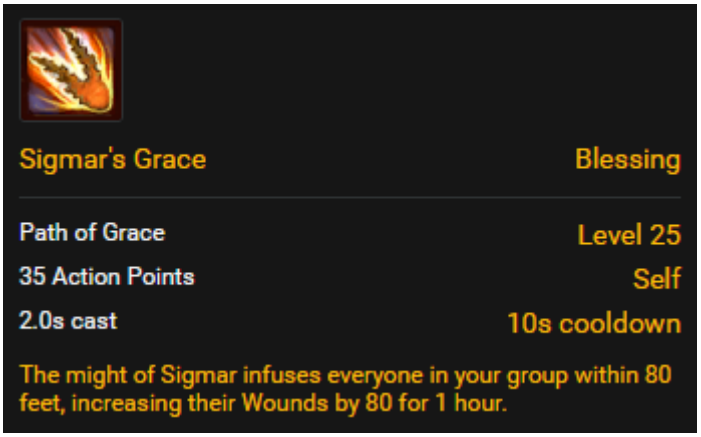
	ORDER	Order kills	TDMG per kill	DESTRO	Destro Kills	TDMG per kill
TOTAL	**15356203**	**1343**	**11434,3**	**8881552**	**863**	**10291,5**
	504070			375856		
	285034			256525		
	446143			137356		
	457625			251995		
	448665			225130		
	405548			163113		
	259678			129486		
	358182			80232		
	291537			152426		
	161201			212742		
	311080			108716		
	273609			98299		
	243295			136428		
	278239			132589		
	196518			147584		
	291100			106714		
	246504			133551		
	302413			77335		
	112897			165051		
	108238			113451		
	193092			130946		
	261262			86170		
	161169			191222		
	119670			139644		

As we showed earlier in the transformed eq.(3), this is equivalent to
$HP * TTTKsf$

where **HP is the average total health** of (of the members of the faction in this case) and TTTKsf is the True Time To Kill Slowdown Factor.

We will now have to make a minor assumption regarding the average Health Pool for each faction. As we showed earlier, the renown distribution (and therefore gear distribution) is fairly similar and after taking a look at killboard it also seems like the majority of the deaths belong to dps and tank classes.

Factoring those in, I assume that the **average base HP of all characters who died is 8500**. Even if this is off by +-500 it shouldn't affect the results too much (see **Appendix**) However, while this is true for both realms, **Order also have Warrior Priests** with their **Sigmar's Grace ability**:



Since we've assumed Perfect Class Distribution we can actually calculate the average HP increase from this ability:

- On an average WP build this ability grants **68 Wounds to each member of the party**.
- Assuming that (**due to the current META**) only **60% of WPs** choose to **spec for that ability**, we get **11 out of 18** WPs using it in this LOTD.
- **11 Warrior Priests** which can each give the **buff to 6 people** (including themselves).
- Since we've assumed Perfect Class Distribution, we get that 11*6 = **66 people got the buff out of the 208 Order players** present.
- 66/208 = 31.7%, meaning that the **average Order player got** 68*31.7% = **21.6 extra Wounds** from this ability (216 extra HP)

Therefore, the **HP total for the average Order character** who died is not 8500, but 8500+216 = **8716 Wounds**

True Time To Kill slowdown factor

First we shall calculate the True Time To Kill slowdown factor:

$$TDMG = HP * TTTKsf \quad \Rightarrow$$

$$TTTKsf = \frac{TDMG}{HP}$$

- Destro deaths: $TTTKsf = \frac{TDMG_{order}}{HP_{destro}} = \frac{11434.3}{8500}$ = 1.345
- Order deaths: $TTTKsf = \frac{TDMG_{destro}}{HP_{order}} = \frac{10291.5}{8716}$ = 1.181

In my opinion, by this point **these numbers *should be raising several red flags***. Let me explain further; to interpret those initial results we should go back to the definition of TTTKsf

When Destro players die, they do so **34.5% slower than if they had no heals**.

When Order players die, they do so **18.1% slower than if they had no heals**.

I will come back to this later, but for now I think it is safe to assume that this indicates how **fast/low Time To Kill is ingrained in the current META**. Basically bursting enemies down before they have any time to heal at all.

Recovery

Finally, we can calculate the faction-averaged & time-averaged Recovery from the above TTTKsf values. From equation (2):

$$TTTKsf = \frac{1}{1-R} \quad \Rightarrow$$

$$1 - R = \frac{1}{TTTKsf} \quad \Rightarrow$$

$$R = 1 - \frac{1}{TTTKsf} \quad \Rightarrow$$

$$R = \frac{TTTKsf - 1}{TTTKsf}$$

- **Destro Recovery**: $R = \frac{1.345 - 1}{1.345}$ **= 0.257**
- **Order Recovery**: $R = \frac{1.181 - 1}{1.181}$ **= 0.153**

To once again translate this into tangible stuff, this means that:
Destro characters who died were getting healed for 25.7% of their incoming damage until they died and
Order characters who died were getting healed for 15.3% of their incoming damage until they died.

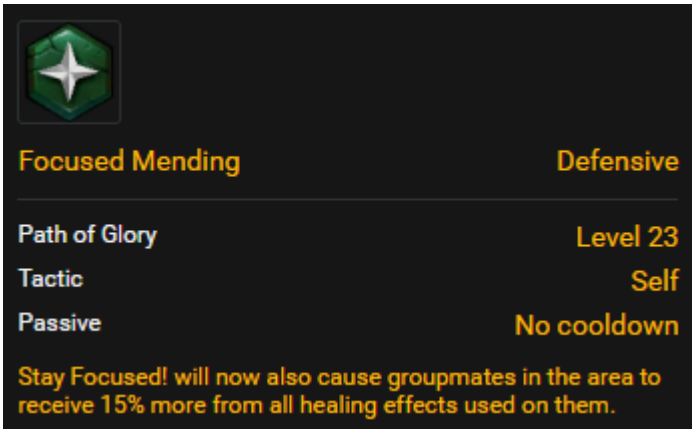
These results come as a shock to me, and I assume also to most people.
I will discuss more about that in the next section.

Interpretation of the Results

Let's start with why these results (at first glance) seem weird.

Order has better sustain tools

Order is, by design, the faction meant to sustain better.
As far as faction specific tools go, Kotbs has both



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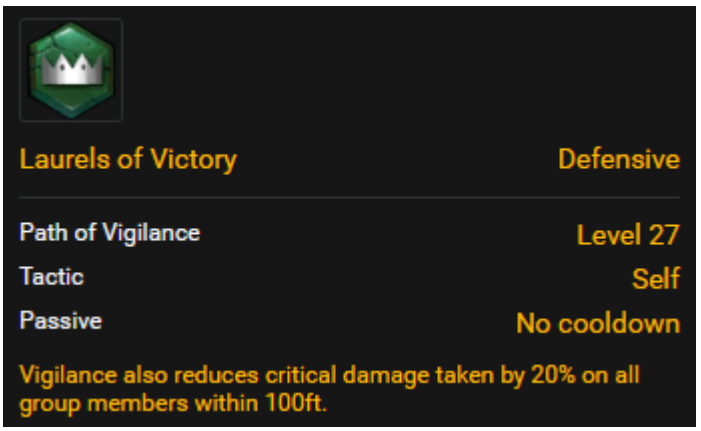
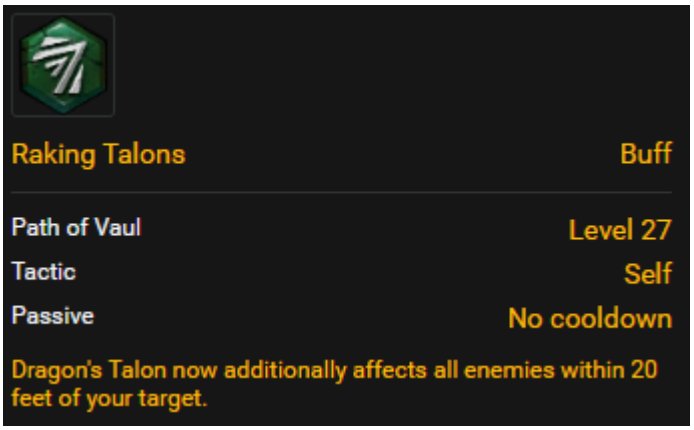
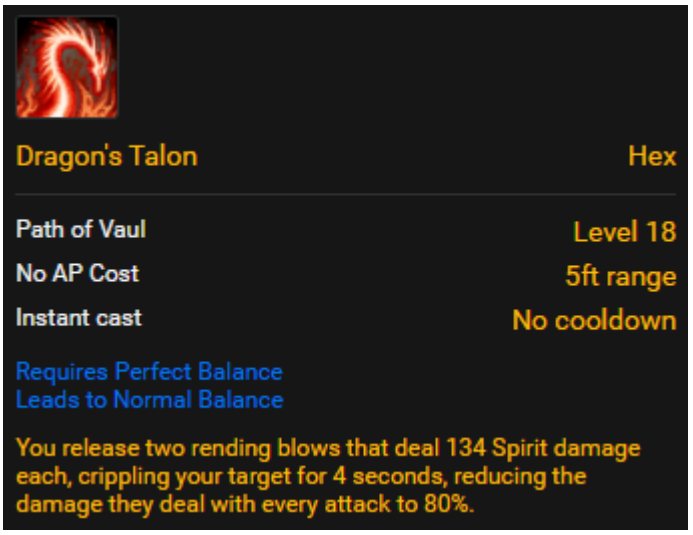


to reduce incoming damage for their party.

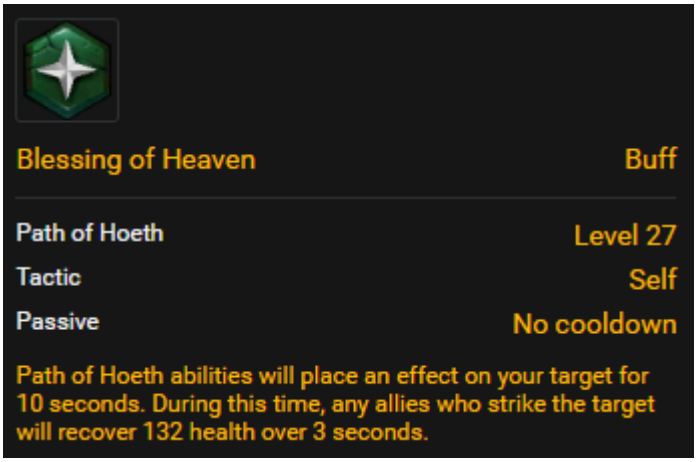
SMs have Raking Talons to ensure Dragon's Talon has pretty much permanent uptime vs the enemy mdps frontline (which reduces their dmg vs all Order enemies)





Chosen meanwhile has an unmirrored 15% party dmg reduction in the form of the new Oppression, on a 25% uptime however.

Finally SMs also have a lot of unmirrored healing options with



being of particular note due to also functioning for all allies that may hit your target (even out of party)

This section was included not to complain about Order's unique tools, but in order to illustrate that as a faction they do indeed possess stronger sustain tools.

So why are the results seemingly contradicting that?

To answer that we have to examine what Recovery actually means

What does Recovery express?

If you recall, in the introduction section we also presented another definition for Recovery in the form of equation (1):

$$R = \frac{THr}{TDMGr}$$

where, **THr** is the **True Rate of Healing [1/s]** = healing rate after heal debuffs and **TDMGr** is the **True Rate of Damage [1/s]** = damage rate after mitigations

Let's now examine the ratio of the Recovery for both factions:

$$\frac{R_{destro}}{R_{order}} = \frac{\frac{THr_{destro}}{TDMGr_{order}}}{\frac{THr_{order}}{TDMGr_{destro}}} = \frac{THr_{destro} * TDMGr_{destro}}{THr_{order} * TDMGr_{order}}$$

$$\frac{R_{destro}}{R_{order}} = \frac{THr_{destro}}{THr_{order}} * \frac{TDMGr_{destro}}{TDMGr_{order}} \quad (4)$$

What this equation describes is that **the ratios between incoming healing and incoming damage (or conversely, the outgoing damage for the enemy faction) define their relative recovery**.

For example, if Destro can do twice as much true damage to Order but can also heal half as effectively as Order do, then the ratio of Recovery for both factions would be the same (½ * 2/1 = 1);

Order would take 2x damage and do 1x heal and
Destro would take 1x damage but do 0.5x heal.

Having equal Recovery (Recovery ratio = 1) doesn't mean that neither side would ever die, just that you would die at the same rate as your enemies

Destruction's design philosophy is about crowd control (Mara AOE kd) **and maneuvering** around the enemy with advanced speed control (BO charge, CoC, GTDC). And, as we discussed before, **Order's design philosophy is about outsustaining the enemy**.

This should theoretically **translate** into a $\frac{R_{destro}}{R_{order}}$ **ratio**

of slightly over 1 (in case Destruction leverages their tools to neutralize Order) or slightly under 1 (if they don't and Order is left to use their defensive tools uninterrupted). In a scenario where Order wins overall, one would expect the ratio to be <1

That is, however, not the case in this LOTD.

What happened in this LOTD

According to the results:

$$\frac{R_{destro}}{R_{order}} = \frac{0.257}{0.153} = 1.68$$

This is not a calculation error, as I made sure to **prove all major assumptions** so far. The only **exception is the HP total assumption** which as I prove on the **Appendix** can only **change the final result** for the ratio just slightly (ratio **between 1.49 and 2.03**)

This is also **very different from the results** of the same analysis in a balanced **City fight the next day**:
Evaluating differences in sustain between factions - City Fight 13/05/24

There I show that the ratio is indeed below 1 (~0.55)

Using eq.(4) again:

$$\frac{THr_{destro}}{THr_{order}} * \frac{TDMGr_{destro}}{TDMGr_{order}} = 1.68$$

If we take these results at face value it would indicate that **Destro was either outDPSing Order** by a lot, was **outhealing Order** by a lot, **or doing a mix of both**.

- A simple look at the **Damage section** of the scoreboard combined with the **Kill Damage** numbers shown before should convince everyone otherwise for outDPSing possibility.

- Taking a look at the **Heal section** of the scoreboard doesn't give away a clear verdict and the total **numbers look nearly equal (**33.2 million for Destro vs 32.9 million for Order)

The final possibility to explain the data is via the LOTD debuff.

Can LOTD debuff explain the results?

For those unfamiliar, **if more than a warband gathers at close proximity** to one another in LOTD, **they get a debuff that will reduce their outgoing damage and healing by up to 50%** (correct me if I'm wrong, couldn't find documentation for it) depending on how many people are gathered there.

Using this we can transform the above equation by substituting these equations in there:

$$THr = THr' * \varepsilon_{LOTD}$$

$$TDMGr = TDMGr' * \varepsilon_{LOTD}$$

Here **TDMGr' and THr'** are the **Damage and Healing rates** that would occur **if the debuff of LOTD wasn't applied.**

ε_{LOTD} is the time-averaged & faction-averaged efficiency due to the LOTD debuff.

For simplicity's sake **I assume that both healers and frontline (dps+tanks) in warbands receive the same debuff**. This is not always the case, but **due to the high level of organization and people sticking together**, I would say this is a reasonable assumption.

$$\frac{THr_{destro}}{THr_{order}} * \frac{TDMGr_{destro}}{TDMGr_{order}} = 1.68 \quad \Rightarrow$$

$$\frac{THr'_{destro}}{THr'_{order}} * \frac{TDMGr'_{destro}}{TDMGr'_{order}} * \left(\frac{\varepsilon_{LOTD_{DESTRO}}}{\varepsilon_{LOTD_{ORDER}}}\right)^2 = 1.68$$

Although I would say that Order blobbed way less than Destruction did, especially at the start of LOTD (I was leading a warband so I would somewhat know) **let's entertain the following example** for now:

- ☐ Order blobs way more than Destruction does, and therefore gets an average LOTD debuff of 30% at all times, compared to 10% for Destro.

  Then the above equation becomes:

$$\frac{THr'_{destro}}{THr'_{order}} * \frac{TDMGr'_{destro}}{TDMGr'_{order}} * \left(\frac{(1-0.10)}{(1-0.30)}\right)^2 = 1.68 \Rightarrow$$

$$\frac{THr'_{destro}}{THr'_{order}} * \frac{TDMGr'_{destro}}{TDMGr'_{order}} * 1.65 = 1.68$$

$$\Rightarrow$$

$$\frac{THr'_{destro}}{THr'_{order}} * \frac{TDMGr'_{destro}}{TDMGr'_{order}} \sim= 1$$

This scenario could theoretically explain what is happening here but there are 3 ''problems'' with it:

1. Order wasn't blobbing THAT much than Destro (if anything I'd say the opposite was happening).
2. If severely debuffed Order dps are able to achieve such Damage and Kill Damage numbers it means that something is way off in the balance between classes/comps of both factions.

3. If this scenario is true, it would indicate that if an Order warband met a Destro warband 1v1, they would overpower them due to an innate overwhelming difference in power that doesn't stem from gear or organizational differences. This is not what is usually observed in the lakes.

   I.e. If Order are winning the fight with a permanent 30% debuff in heals & damage vs an enemy with a 10% debuff, then removing that debuff would mean the base power difference between the two was already extremely skewed.

I find this to be **very unlikely to be the sole explanation** for our results
So what the hell is happening here?

Conclusions & what the value of Recovery hides…

First, **let's recap**. We have:

- Similar degree of Organization
- Similar gear between factions
- Destruction Recovery being significantly higher than Order (despite innate faction design promoting the opposite relation)

and according to my (and more wb leads testimonies)

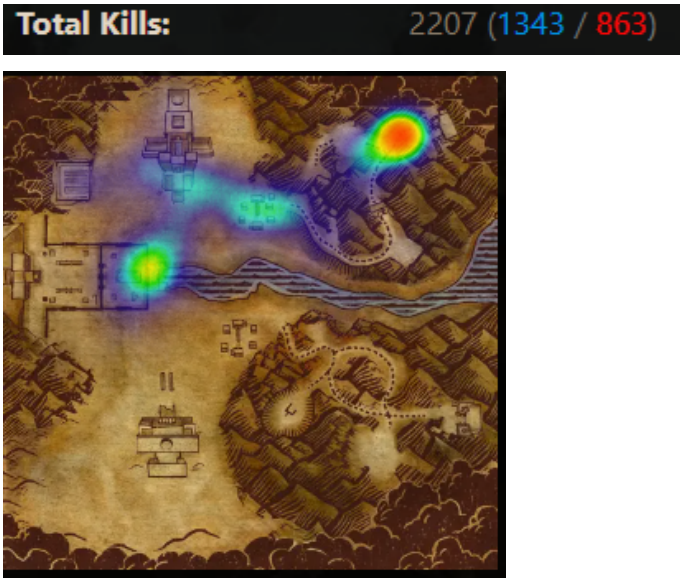
- Order not blobbing significantly more than Destro

Recovery is a nice metric and can reveal a lot as I have thus far shown however it **does not give any information about fights that don't end in kills**.

Remember that equation (2) holds true only if $R \in [0,1)$. For Recovery values of 1 or above, the killboard records no Kill Damage because there was no kill.

The answer, in my opinion, lies here:

With the information shared in the recap one would assume that Destro would have the upper hand, or at least come out as equals to Order. However the reality is different:



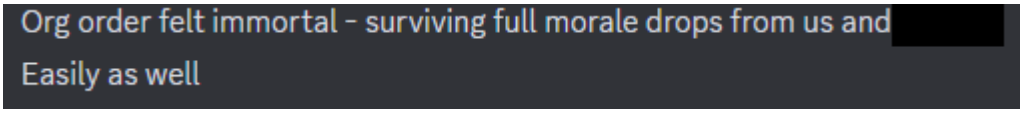
How could Order have way less deaths if they sustain worse?

It's simple.

Because they died (and Destro won) **only in the fights where their healers were flanked/caught off guard/CCd/outnumbered or the people they were supposed to heal were overextended. This is actually reflected in the Recovery value** that is way too low for Order.

In most other fights Order simply out-sustained (and most likely also out-DPSd) Destro.
Recovery isn't representative of all the fights Order partook in because they simply didn't die at all in most of them.

This also lines up with the experience of Destro leaders:



If this is the case, what is exactly at fault?

Hard to tell with the data I have. **<u>This is up to the hands of the balance team to figure out.</u> This analysis can also be repeated by them for other LOTDs (that are decently equal) or other skirmishes too.**

If I had to guess I would say it could be a **combination of** some of the things below:

- **Class imbalance** between factions (e.g. WL vs other Destro mdps)
- **Persistent proc META** that can be **used better by** one side (e.g. BW procs on **high hit-frequency AOE abilities** like Whirling Axe)
- The above would not be such an issue if not for the **availability of more interrupt options for Order faction** and especially **in already high demand classes** (SMs, WLs) which can reliably shut down enemy mdps channel drops.
- **Decreasing the AOE range of mdps abilities** which indirectly **increases healer output (due to less pressure** on them) **combined with Order being able to heal better** than the Destro **by design** (see ‘’Order has better sustain tools’’ section)
- **SMs** being able to **bypass LOTD debuff mechanics with** their **‘’Blessings of Heaven’’** unmitigatable out-of-party healing (also **see Heal section in killboard** and what places SMs ended up on)
- **Crowd Control and relative ease of repositioning not being an effective tactic vs large numbers** of enemies especially due to the existance of **OOP heals** and enough people to stop advances or set up funnels in most spots Destro could theoretically maneuver around to flank.

If you can come up with any additional interpretations of the results, by all means, share it with us in the forum post. Alternatively you can reach out to me on ROR discord or in game.

Would love to hear your opinions.

Appendix

Assumption about average base HP total

Getting the assumption about the base HP of the characters who died slightly wrong can have a small impact on the results.

I will assume that the **maximum deviation** of the average HP from 8500 (which we used above) is **500 wounds**. **This means that the average HP could either be 8000 or 9000 at the two extreme cases.** Here is how that affects the results:

8000 base HP:

- Destro deaths: $TTTKsf = \frac{TDMG_{order}}{HP_{destro}} = \frac{11434.3}{8000}$ = 1.429
- Order deaths: $TTTKsf = \frac{TDMG_{destro}}{HP_{order}} = \frac{10291.5}{8216}$ = 1.253

- Destro Recovery: $R = \frac{1.429 - 1}{1.429}$ = 0.300
- Order Recovery: $R = \frac{1.253 - 1}{1.253}$ = 0.202

$$\frac{R_{destro}}{R_{order}} = \frac{0.300}{0.202} = 1.49$$

9000 base HP:

- Destro deaths: $TTTKsf = \frac{TDMG_{order}}{HP_{destro}} = \frac{11434.3}{9000}$ = 1.270
- Order deaths: $TTTKsf = \frac{TDMG_{destro}}{HP_{order}} = \frac{10291.5}{9216}$ = 1.117

- Destro Recovery: $R = \frac{1.270 - 1}{1.270}$ = 0.213
- Order Recovery: $R = \frac{1.117 - 1}{1.117}$ = 0.105

$$\frac{R_{destro}}{R_{order}} = \frac{0.213}{0.105} = 2.03$$

Link to my calculations

My calculations were performed in:

LOTD calculations

If you have reached this point, I would like to personally thank you.
I hope you enjoyed my analysis as much as I did.

by

Only

of

<Entropy and Chaos>