Risk: Calibrating Likelihood and Consequence

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Presented by

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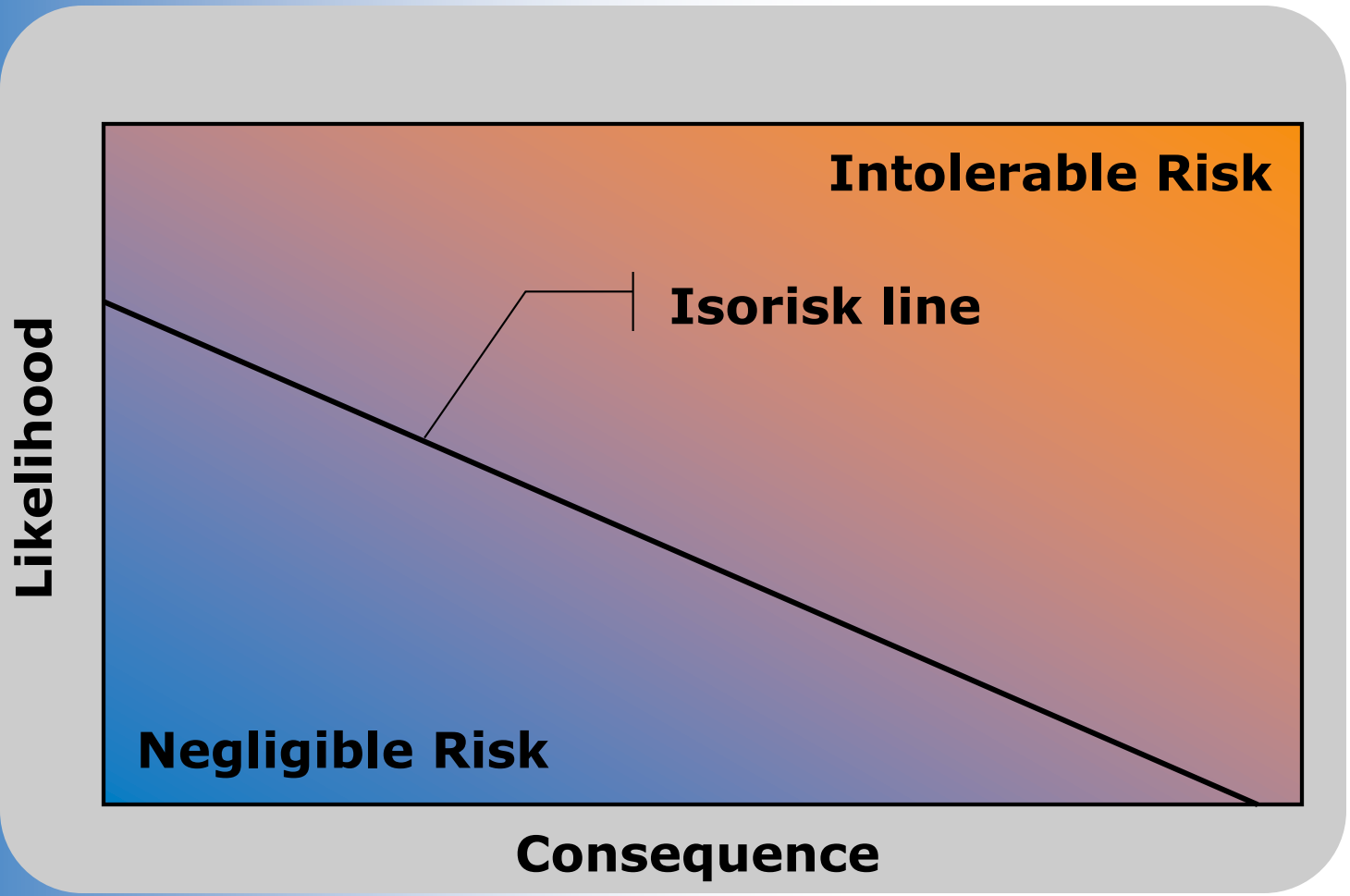
Risk—What metrics?



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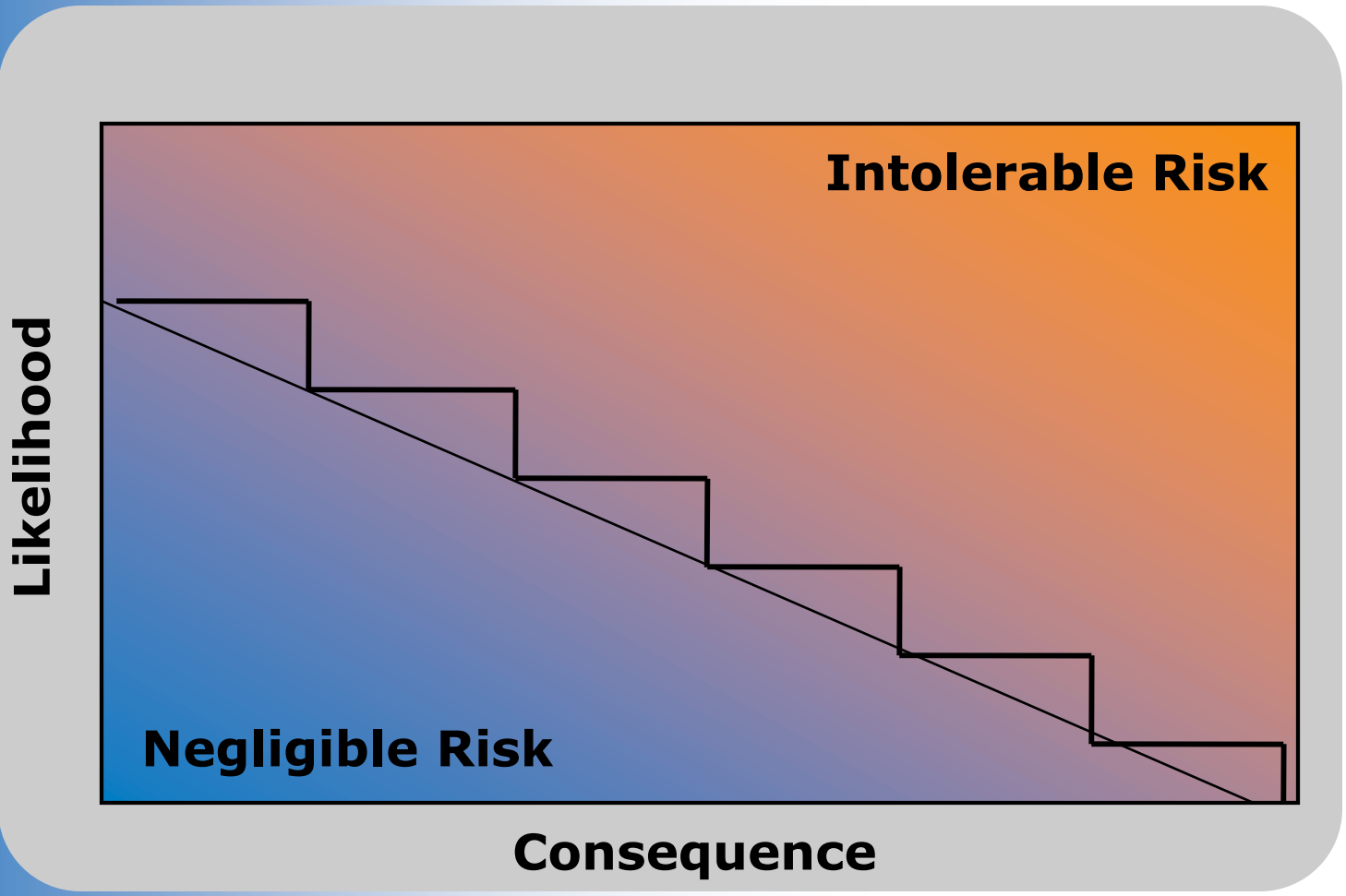
Categories

- **Log-log → Separated by orders of magnitude**
- **Avoids unreasonable precision**
- **Addresses uncertainty of estimates**

Isorisk line becomes stepped



Likelihood Categories

- **Frequency, not probability**

1/year	**Likely**
1/10 years	**Occasional**
1/100 years	**Seldom**
1/1,000 years	**Rare**
1/10,000 years	**Unlikely**

Likelihood Categories

- 1/year — Likely
- 1/10 years — Occasional
- 1/20 years — Seldom
- 1/100 years — Rare
- 1/300 years — Unlikely

What of consequences?

- **Two words: events and impacts**
- **Impacts are real concern**
- **Impacts to consider:**
  - **Safety**
  - **Community**
  - **Financial**
  - **Environment**

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Safety Impacts

- **Most common benchmark: 1 fatality per event**
- **Orders of magnitude**
  - **10 fatalities per event**
  - **1 fatality per event**
  - **0.1 fatality per event**
  - **0.01 fatality per event**
  - **0.001 fatality per event**
- **What is 0.001 fatality per event?**

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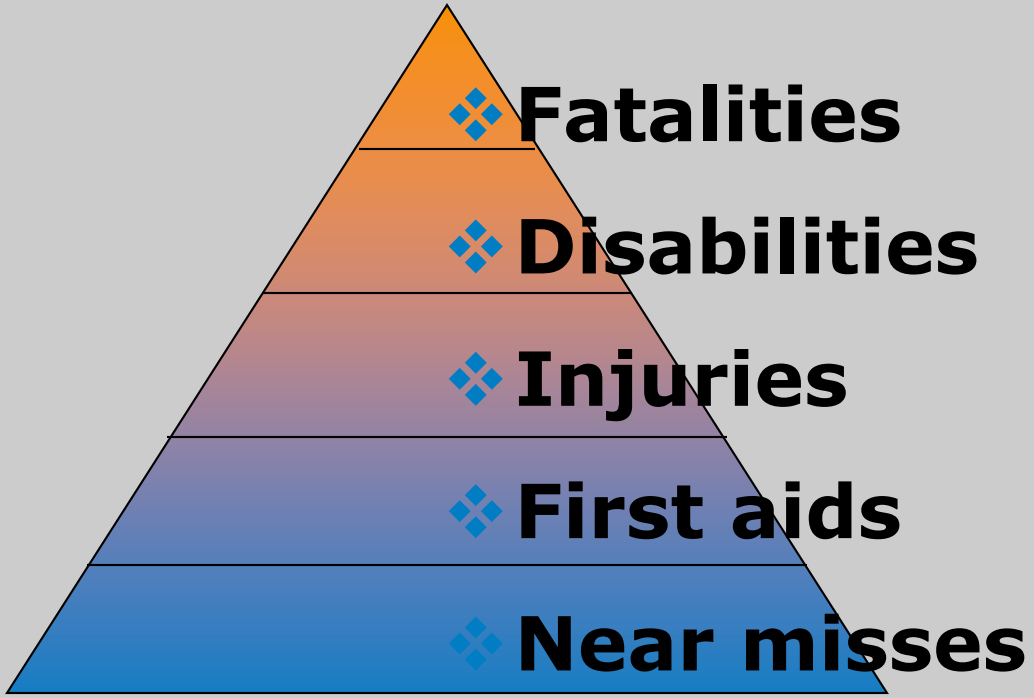
The Accident Triangle



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Safety Impact: Relative Severity

Fatality	1.0*x*
Disabling injury	0.1*x*
Injury (recordable)	0.01*x*
First aids	0.001*x*

Community Impact

- **General agreement that impact to community is order of magnitude less tolerable than same impact within facility**
  - **Fatality in community is 10x more severe than fatality in plant**
  - **Any kind of injury in community is 10x more severe than same injury in plant**
  - **Complaint in community is as severe as first aid in plant**

Financial Impact

- **Also called “site”, “asset”, “commercial”**
- **Metric is $/event**
- **Separating by orders of magnitude is straightforward**

Financial Impact Categories

A bad example:

< $20,000	No impact
< $100,000	Low
< $1,000,000	Severe
< $75,000,000	High
> $75,000,000	Very high

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Financial Impact Categories

A better example:

< $10,000	Very low
< $100,000	Low
< $1,000,000	Medium
< $10,000,000	High
< $100,000,000	Very high
> $100,000,000	Extremely high

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Financial Impact – A Challenge

- **Setting benchmark establishes equivalency with fatalities**
  - **Too low, face accusations of not valuing human life**
  - **Too high, plaintiffs attorney's use in lawsuits**
- **Typical benchmark is around $1 to 2 million**
- **Many companies do not address asset impact with RTC**

Environmental Impact

- **Typically not done well**
  - **Categories are ambiguous**
  - **Categories are not separated by orders-of-magnitude**
  - **Benchmark category is poorly aligned with other impacts**

Environmental Impact

A typical example in use today:

- **Minor release, less than reportable quantity (RQ)**
- **Moderate release, exceeds RQ, minor impact**
- **Significant release, exceeds RQ, medium impact**
- **Significant release, exceeds RQ, major impact**

Environmental Impact

A better example:

- **< RQ — Minor**
- **< 10 x RQ — Moderate**
- **< 100 x RQ — Severe**
- **< 1000 x RQ — Very severe**
- **> 1000 x RQ — Extremely severe**

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Environmental impact metrics

- **Five types of dimensions**
  - **Economic***
  - **Thermodynamic***
  - **Environmental**
  - **Ecological**
  - **Socio-political**

  ***Often addressed as part of financial impacts**

Ecological metric example

- **Time it takes for environment to recover from the event**
  - **< 0.2 days (5 hours) to recover**
  - **< 2 days to recover**
  - **< 20 days (3 weeks) to recover**
  - **< 200 days (7 months) to recover**
  - **< 2000 days (5 years) to recover**
  - **> 2000 days (5 years) to recover**

Socio-political metric example

- **Measure severity of environmental harm by the value society places on it, in terms of public outrage**
  - **< complaint to facility**
  - **< local news coverage**
  - **< regional news coverage**
  - **< national news coverage**
  - **< global news coverage**
  - **> global news coverage**

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Environmental metric examples

- **Habitat damaged**
  - **< 1 acre**
  - **< 10 acres**
  - **< 100 acres**
  - **< 1,000 acres (1.6 sq.mi.)**
  - **< 10,000 acres (16 sq.mi.)**
  - **> 10,000 acres (16 sq.mi.)**
- **Shoreline contaminated**
  - **< 0.05 miles (100 yards)**
  - **< 0.5 miles**
  - **< 5 miles**
  - **< 50 miles**
  - **< 500 miles**
  - **> 500 miles**

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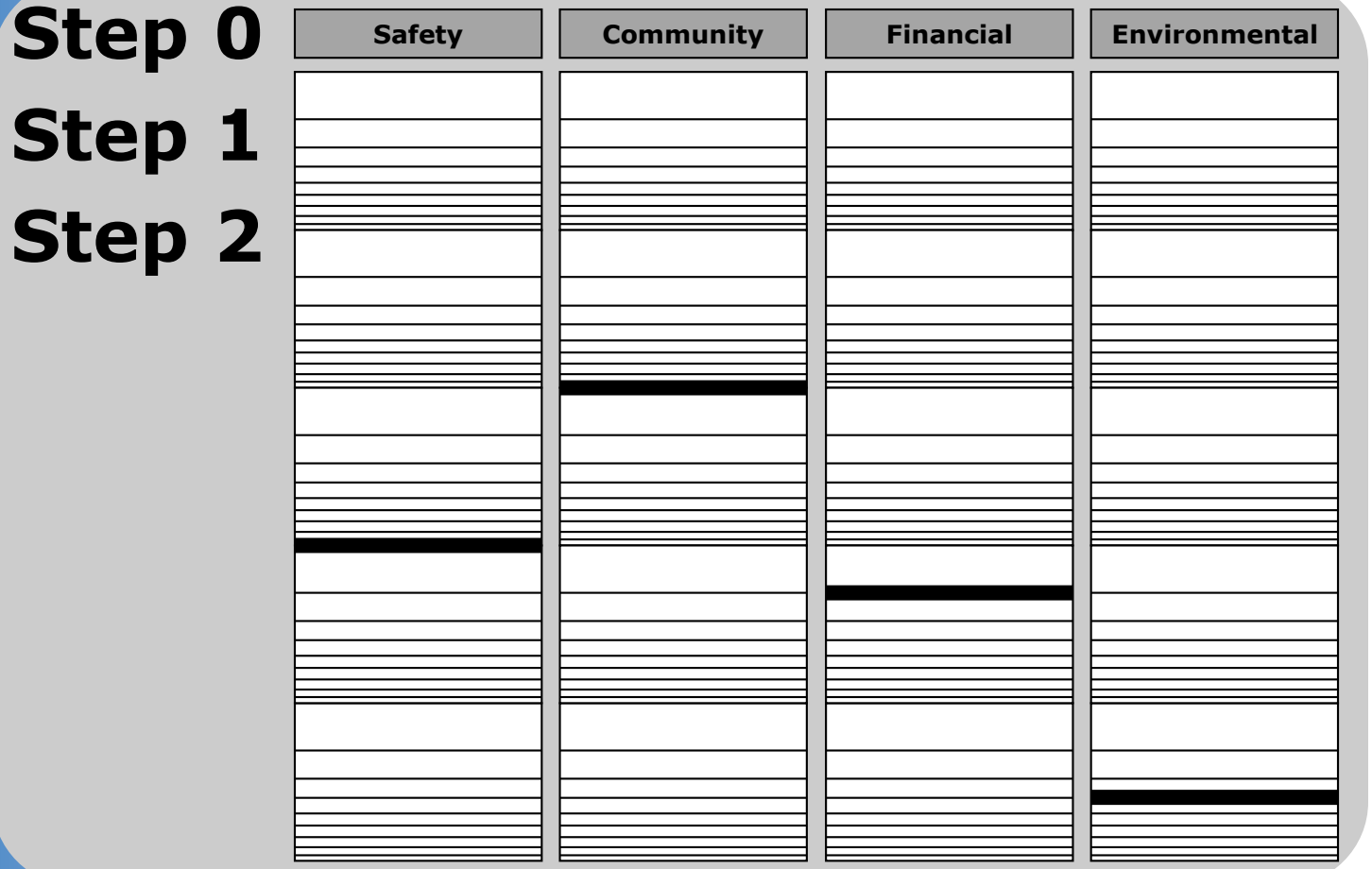
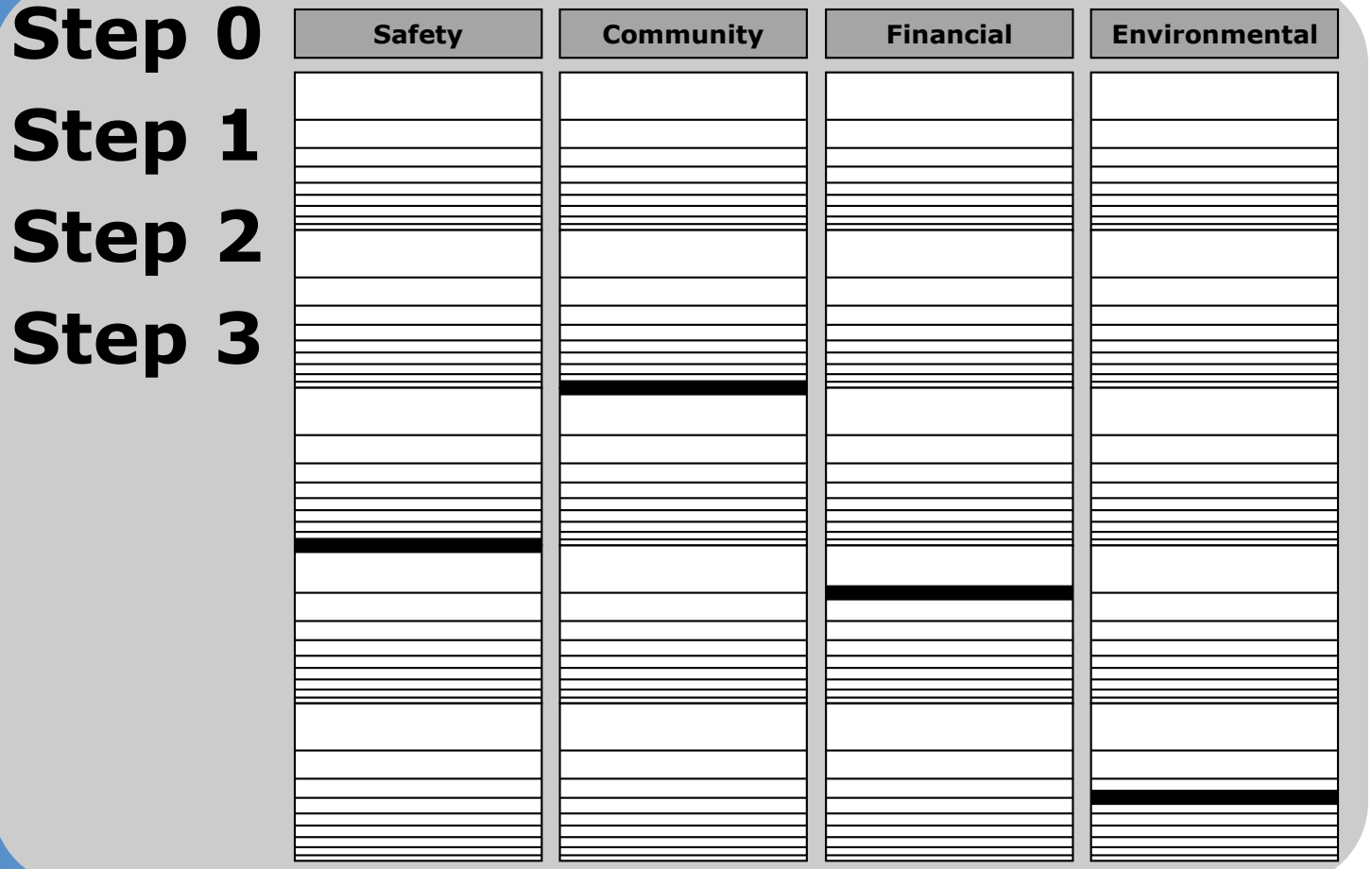
Aligning Impact Vectors



Aligning Impact Vectors



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Impact Equivalency

- **Step 0:**
  Choose impact vectors
- **Step 1:**
  Divide into orders of magnitude
- **Step 2:**
  Benchmark each impact vector
- **Step 3:**
  Align with benchmark frequency

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Summary

- **Risk lines are log-log plots of likelihood (events per year) and consequence (impact per event)**
- **Likelihood and consequence (impact) categories should be separated by orders of magnitude**
- **Impact vectors can include safety, community, financial, and environment**
- **Set impact categories by dividing into orders of magnitude, choosing benchmarks, and aligning various impacts**

Questions?